POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884

FRED R. LOW, *Editor*

Volume 70 NEW YORK, SEPTEMBER 24, 1929 *Number 13*

Standardization

IT is said that Lord Kelvin made to odd dimensions every bolt, nut and screw in the apparatus that he turned out, so that purchasers would be compelled to come to him for repair parts.

This, if true, is only another example of the tendency of even great minds to regard projects of large human interest from the point of view of their effects on their own bank accounts and individual prospects.

And more often than not the project, if broadly carried through, would not only result in general benefit but would react favorably on the business and condition of the objector himself.

Many can remember the days when the engineer who took off a cylinder head or valve chest cover had to lay the nuts by in their consecutive order or string them so that each would go back on its proper stud.

How the business of electrical supplies would be hampered and the general use of such appliances hindered if one had to look out for fits as well as fitness in making his purchases.

The benefits of standardization, uniformity and simplification have not begun to be appreciated.

Their greatest good comes not so much in the saving of time and effort and inconvenience to the individual user, although this is great, as in the cheapening of products and services that he buys through their effects on mass production and simplified distribution.

Standardization, or even simplification, does not mean the stamping out of individuality or the reduction of things to a monotonous sameness, but it does mean the large-scale production of things that will fit into the general purpose and the possibility for the user to find in ordinary sources of supply at a reasonable price the thing adapted to his needs.

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Don't Overlook The High-Pressure Trend

MANY manufacturers of steam specialties are enjoying today (as they have for many years past) a large business in equipment for low and moderate pressures. The volume of such business may be so satisfactory and the present apparent field for the sale of high-pressure equipment so restricted that the manufacturer may see little advantage in seeking and filling high-pressure orders. Why should he place an extra burden on his design department, go to the trouble and expense of making new patterns and make special arrangements for sound steel castings or forgings to replace cast iron? Can the profits from a few additional sales possibly justify the expense?

This problem must not be viewed too narrowly. The high-pressure field, still somewhat restricted, is expanding steadily. Sooner or later the manufacturer of steam specialties must shoulder the expense of adapting his own product to higher pressures. Why should he not do it now and "get in on the ground floor" with this new business? Then, with other progressive manufacturers, he can utilize the high-pressure development period to accumulate experience, develop field contacts, earn customer confidence and build up manufacturing facilities.

Already a surprising number of manufacturers of boilers, superheaters, turbines, safety valves, steam gages, water columns, feed pumps, blowoff valves, piping, etc., have done just what is recommended here. These are in a position to assume (or maintain) leadership in the immediate future.

Instruments— The Entering Wedge

WHERE a power plant is obsolete and adequate appropriations for modernization are refused, the engineer faces a difficult problem. In most cases he can be sure on general principles that the plant is losing heavily; to demonstrate that loss to the owners is another matter. Meters may end his troubles.

While the task of getting money enough for complete modernization appears hopeless, he may see his way to a smaller appropriation. The question arises whether this money should be used to modernize a portion of the actual equipment used in power generation or transmission, or whether it should be spent for instruments.

The latter course might seem like that of the man who spent his last dollar for a pocketbook. Why spend money for meters to record the exact performance of a plant where obviously that performance is far below standard? However, there may be a method in such madness. First, the meters can give the operating results for the plant "as is." A well-presented comparison of the results recorded with those obtained in modern plants will set the head office thinking. Next, with the aid of meters, a very substantial improvement can generally be made in the operation of the existing equipment, and the reality of this improvement can be demonstrated to the management.

The next step is to determine the best type of equipment and the best layout for the complete modern plant. Prices and guarantees of performance can be obtained which, when compared with present performance (as indicated by the instruments), will quickly show the management what the improvements will mean from the point of view of dividends.

Having built up confidence, the engineer will be in a fair way to obtain the appropriation for a modernized plant, assuming, of course, that the business is financially sound.

And, finally, when the plant is modernized, the instruments are not wasted. Unlike new patches on old clothes, they can be easily shifted and reapplied to the new equipment, where, if the engineer's figuring has been sound, they will demonstrate to him and to the management the savings he has predicted.

Japan's Largest Hydro-Electric Plant

ENGINEERS and their friends attending the World Engineering Congress in Tokio will have an opportunity to visit many of the power and other engineering projects in the island empire. Probably none of these will combine more interesting features in a single project than the Saku hydro-electric development described in this issue of *Power*.

This plant is the largest of its kind in Japan, a fact that gives it a special significance. The large amount of sediment carried in the water required the installation of a sand basin near the tunnel intake. Such installations have been made in this country, but they are not common. The tunnel was driven more than seven miles through mountains of cinders, gravel and boulders. In a number of places quicksand and large volumes of water were encountered, which involved special construction.

The tunnel discharges into a regulating reservoir that is used in such a way as to maintain a fairly constant flow in the tunnel with a varying load on the plant. The fifteen-foot pipe line from the regulating reservoir to the penstock connections and the large differential surge

tank are also worthy of attention. These features alone make this development of particular interest, but the outstanding feature is that the plant has been made earthquake-proof. How this affects the design is well illustrated in the surge tank, that contains thirty-three per cent more steel than a similar tank in this country.

Most of the machinery in the plant was built in the United States and is little different from that to be found in many plants in this country, but the conditions that had to be met make the project unique in many respects and of special interest.

Begin at the Beginning

WORDS of wisdom appeared in the last number of *Power,* over the signature of Prof. C. H. Berry, of Harvard University. He told the young engineering graduate who hoped to succeed in power engineering that he should start in the boiler room, on boiler room operation and that he should enter whole-heartedly into the work there, making no attempt to hold himself separate from the rest of the force.

Professor Berry's remarks are worthy of the consideration of any man new from college who intends to be a power engineer. As he pointed out, power engineering includes design as well as operation. Just as the boiler room is the necessary first step for the successful plant operator, so the drafting board is the essential preliminary to successful design.

Too many budding engineers acquire a distaste—even a contempt—for drafting before they have tried it. This is a mistaken attitude. Drafting may bring low pay, but until an engineer has served his time in the actual layout of power plants he cannot hope to be a good designer. In fact, knowledge of both operation and drafting must be the preliminary to design work, and no young man ambitious to succeed in power engineering dare shirk this part of his education.

St. Lawrence Power In the Limelight Again

ACQUISITION by J. P. Morgan & Company of the Frontier Corporation, representing a 2,400,000 horsepower site on the St. Lawrence, and following so closely upon acquisition of Niagara Falls power by the same interests, has served again to place water power in the front-page headlines of the metropolitan dailies. The immediate declaration by Governor Roosevelt that he will seek to have the next session of the New York Legislature provide for development by the state, indicates that the subject is to be made a political issue that may in the end be settled by a referendum.

As a matter of fact, the Morgan purchase, aside from indirectly forcing the issue, leaves the status of St. Lawrence development about the same as it has been for several years. The application by the Frontier Corporation for a permit to build the dam formed the subject of a lively issue between Governor Smith and the State Water Power Commission in 1926, as a result of which the application was withdrawn.

Not only is the consent of New York State necessary to such development, but that of the Federal Government and Canada must also be obtained. It is unlikely that the Federal Government would offer any objection to such a project, providing it adhered to the terms prescribed by the water power act. But just at present Canada does not need St. Lawrence power, in view of the extensive developments now going on in the Province of Quebec, and public feeling is not at all sympathetic toward sending any more power over the border until this country shows a disposition to be more considerate in matters of tariff.

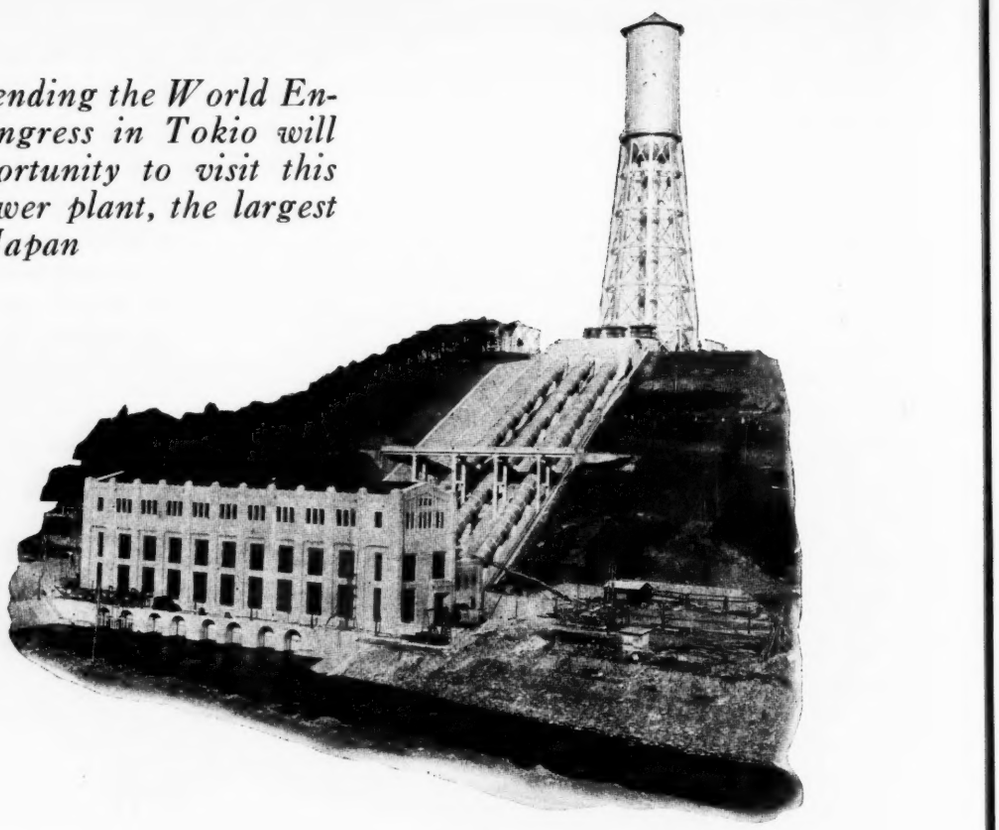
Presupposing that present obstacles will have been surmounted, development and control of the entire upstate water powers by a single large organization would probably mean more economical utilization of the power, and as far as regulation is concerned responsibility would be centralized. On the other hand, there is no denying that this acquisition by Morgan interests will furnish one more example to those individuals who have visions of the country dominated by a power trust. The situation is bound to furnish political capital, which is most unfortunate and is likely to delay development. Whether, in the end, the St. Lawrence be developed by private capital or by the state and the energy be distributed over private systems, industry awaits the power.

At Home Abroad

JUST now many foreign engineers are in the United States making a short visit en route to the World Engineering Conference in Tokio. Most of these men seldom have an opportunity to visit in this country, so that while they are here they will wish to see as much as possible. Industrial plants, power plants and other developments are of a kind and on a scale to which they are unused. If they are to profit to the utmost from what they see, American engineers must afford them every facility and do their best to see that the visitors from Europe are truly "at home abroad."

It is hard to find a manufacturer of power equipment who does not use welding to some extent. Some are making wide application of the process. Others are restricting it to special work sufficient in volume to keep two or three welders busy. There is a distinct advantage in carrying on a certain amount of welding in the shop even where the manager cannot see any opening for its extensive use. New applications are developing daily and some of these will eventually find their way into his plant. Meanwhile he does well to "keep his hand in" at this sort of work and maintain the nucleus of a trained personnel.

Engineers attending the World Engineering Congress in Tokio will have an opportunity to visit this 36,000-hp. power plant, the largest of its kind in Japan



By K. Tsuruta
Chief Engineer,
Kanto Hydro-Electric Power Co.

Saku Hydro Plant

Designed Earthquake Proof

FEATURED by a large differential surge tank, the first in the country, and a 15-ft. diameter steel pipe line nearly a mile long, the Saku Plant of the Kanto Hydro-Electric Power Company is the largest of its kind in Japan. The development was completed and the plant ready for operation early in the present year. It utilizes the water of the Tone River, which finds its source on the eastern slope of the long range of snow-clad mountains forming the backbone of the country and flows into the Pacific Ocean. This plant has a natural advantage in that it is located only 80 miles from Japan's biggest power-consuming center, Tokio, at the end of the Kanto Plains, which fact helped to reduce transportation and transmission costs.

The diversion dam spans a valley 360 ft. wide and of an andesite formation. Built in a funnel shape, the intake structure has a curtain wall extending along its entire frontage of 102 ft., with six inlets 12.5 ft. wide x 9 ft. high built submerged to avoid the large quantities of floating débris. Screens and stop logs are provided at each inlet. The entering water is guided by walls and led to a bell-mouth tunnel with three gates. The floor of the intake tapers down to three débris traps, so that in time of turbulent water all large material is sluiced out before entering the tunnel.

Owing to the steep slopes and the proximity of the watershed, large amounts of débris are brought down by the floods. There have been numerous instances of having to stop the water and clean the waterways of deposited sands where means of elimination were inadequate. Thus the problem of sedimentation is important. In the present case we were fortunate in being able to secure a favorable site of adequate size for the sand basin 600 ft. from the intake. The tunnel connecting the intake and the sand basin is built with a slope of 1 to 1,000, and of smaller cross-section than the main tunnels to give a velocity high enough to prevent deposit of the suspended materials. The sand basin has an over-all length of 600 ft., a maximum width of 180 ft., and an average depth of 20 ft. For normal flow the mean velocity is 0.5 ft. per sec., which is assumed to be low enough to deposit all objectionable materials. A dividing wall extends the entire length of the center of the basin, so that one-half of the basin can be cleaned at a time.

Except for three short cut-and-cover sections aggregating 768 ft., the entire waterway from the sand basin to the regulating reservoir consists of concrete-lined tunnels having horseshoe cross-sections 18.5 ft. wide x 18.5 ft. high, a slope of 1 to 2,000 and a discharge capacity of 1,750 c.f.s. The length of 7.35 miles is made up of eleven tunnels, the longest being 1.37 miles.

At the end of the tunnel is a regulating reservoir of 30,000,000 cu.ft. capacity, which is sufficient for the daily load fluctuations.

Since the earthquake of 1923 all important structures in Japan are required to be earthquake-proof. In our

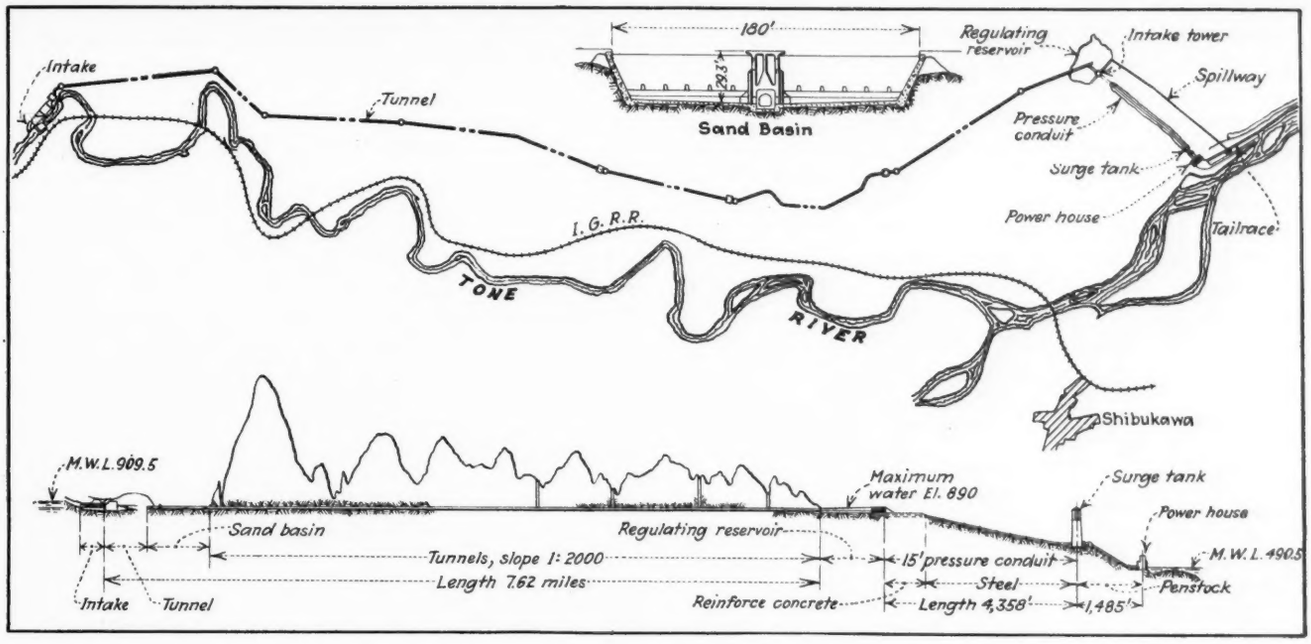


Fig. 1—Except for three short cut-and-cover sections, the waterway from the sand basin to the regulating reservoir consists of concrete-lined tunnels

case, it was necessary to design the dam to resist an earthquake having a horizontal acceleration of 2,000 mm.p.s.p.s. for the reservoir full and 1,000 mm.p.s.p.s. for the reservoir empty. Theoretically, a triangular dam is most advantageous, as the larger the rectangular top section, the larger will be the overturning moment induced by an earthquake. The vertical water face is required to have a batter. The seismic force acting in case of an empty reservoir will throw the resultant force outside of the middle third in the case of the ordinary section. Hence, the top width is as small as possible, and sometimes it will be advantageous to use a light reinforced-concrete structure. Other points to be considered in designing a dam to be earthquake-proof are: The unit weight of masonry must be reduced by the amount of the vertical component of the seismic wave acting; the height of the water wave induced by the earthquake is considerable and increases proportionally with the height of the dam.

The tunnel outlet and the pressure conduit tower intake are connected by a reinforced concrete pressure pipe (see Fig. 1). The purpose of doing this is to use the water at full-reservoir level at light loads. The reservoir is filled by spilling from the crest of the intake structure. During dry periods it takes 20 hr. to refill the reservoir after the plant has discharged its peak-load draft. In this way water is saved, and in addition an average of 7.5 ft. of head is obtained. The intake structure is 50 ft. in diameter and has four gates which are opened during peak loads.

Leading from the regulating reservoir to the differential surge tank, the pressure conduit is 15 ft. in diameter. The first 1,000 ft. of its length, where the head is about 60 ft., is built of reinforced concrete pipe. The steel pipe is from $\frac{9}{16}$ to $\frac{3}{16}$ in. thick. Owing to its large size, the pipe line is provided with steel saddles built in the shape of girders resting on the back of a channel embedded in concrete supports 22.5 ft. apart. On both sides of the steel saddle are 6 x 4 x $\frac{1}{2}$-in. stiffening angles, used chiefly to resist the large stresses induced when the pipe is partially filled. Anchor blocks are inserted about 450 ft. apart. It was possible to put expansion joints midway between the anchor blocks and relieve them of the large thrusts due to expansion and contraction. Expansion joints are of the telescopic type built of steel plates. Air valves are placed about 450 ft. apart.

A large earthquake-proof surge tank was required. Designing such a topheavy structure against earthquakes

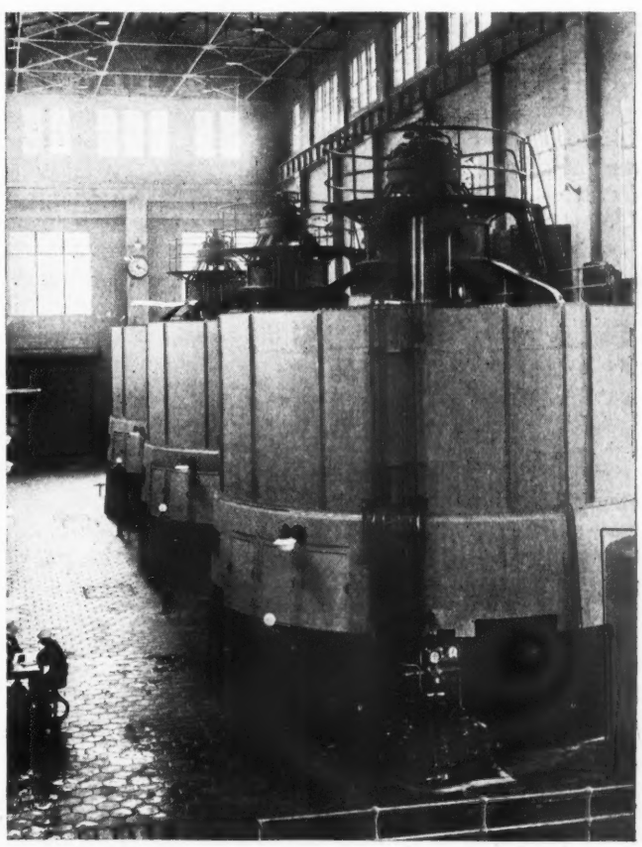


Fig. 2—The power house contains three 28,000-kva. 11,000-volt 50-cycle generators

caused many changes from prevailing designs. To reduce the mass of the tank body and its water content as much as possible, it was decided to use the differential type, as it would require only about one-half the cross-sectional area of a simple tank for the same purpose. The advantage of the differential surge tank can be seen when the overturning moment induced by an earthquake is compared with that caused by wind pressure.

In this case the tank was designed for a horizontal seismic acceleration of 1,500 mm.p.s.p.s. The total overturning moment in kip feet (1,000 ft.-lb.) is 211,760; whereas the turning moment caused by wind pressures

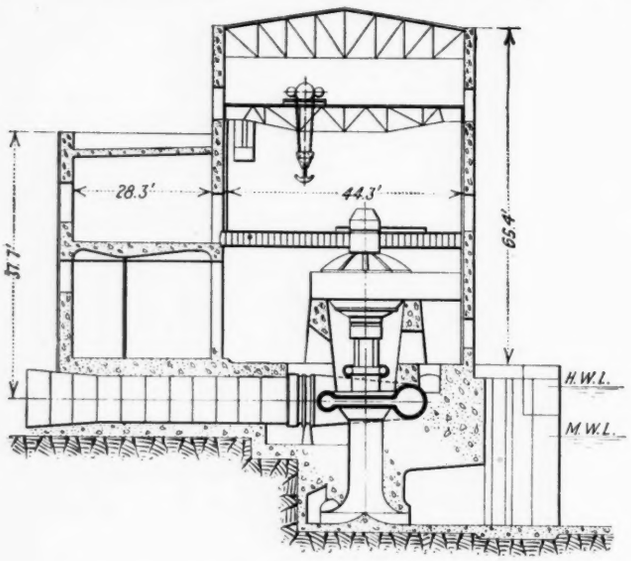


Fig. 3—To simplify operation the generator floor has been omitted from the power house

of 40 lb. per sq.ft. on the tank body and 60 lb. per sq.ft. on the projected area of the supporting structural frame is 61,000, the ratio being about 3.5 to 1. The total weight of metal, exclusive of the standpipe, in the tank is about 1,000 tons, while the same structure in the United States as designed for wind pressure requires but 750 tons.

The shell of the tank was designed to resist the horizontal shearing stress induced by the earthquake, the shearing stress being caused by the horizontal component of the seismic force acting on the water and the metal.

The elastic theory was used, considering each half ring as an arch fixed at one end, since, from symmetry, the tangent at that end does not rotate. Then the neutral point method was used, dividing the arch into small elements; and, integrating the forces, the bending moments induced by them were calculated. The result was that an 8 x $3\frac{1}{2}$ x $\frac{3}{4}$-in. angle was required for each shell plate of seven-foot height to stiffen the shell against the large deformation set up by the forces. The balcony girder was designed on the same principle, taking care of the thrusts induced by the posts. On the outside two 8 x 8 x $\frac{3}{4}$-in. angles were riveted to the tank at each post, extending from top to bottom, as an additional safe guard against earthquake disturbances.

The foundation consists of a reinforced-concrete annular slab, 100 and 60 ft. in external and internal diameters, respectively, and 6 ft. in thickness, carrying eight pedestals to support the posts of the tank.

General dimensions of the elevated surge tank are: Diameters of the tank, 41 ft.; height of the cylindrical part, 84 ft.; diameter of the internal riser, 12 ft.; depth of the hemispherical bottom, 17 ft. 3 in.; the bottom is connected to a flat diaphragm 20 ft. in diameter, which acts as an expansion plate for the 15-ft. diameter standpipe connecting the tank and the conduit; height of the posts, 178 ft.; diameter of post circle at the foundation, 76.625 ft., giving the posts a batter of 1 to 10; and the total height of the tank above its pedestals, 262 feet.

Dividing the flow of the fifteen-foot conduit into three ten-foot penstocks just below the surge tank, the penstock manifold proper is designed to offer the least hydraulic disturbance to the flow of the water, either for the operation of any one or two or all of the three branch pipes. Two fish-shaped partitions at the intersection lines act as tension members for tying the somewhat flat surfaces together. The junctions of the two ten-foot diameter branches are extended inward, thereby forming deflectors to separate the stream lines and at the same time to reinforce the necks of the manifold.

Power House

The power house is built with one floor, the generator floor having been omitted. To expedite the work, it was built with a structural-steel frame enveloped with reinforced concrete. In this way it was possible to carry on the building construction simultaneously with the erection of the machinery after the steel framework was completed. To reduce the draft head as much as possible, the turbine floor is placed six feet below the maximum flood-water level. The draft tube is of simple construction. The chamber surrounding the bell-shaped hydraucone discharge is an arch supported by a solid center pier.

To gain about eight feet of head a tailrace canal about 2,150 ft. long was excavated and its side slopes faced with precast concrete slabs. A spillway conduit built in cut-and-cover sections connects the regulating reservoir with the tailrace canal. This spillway dis-

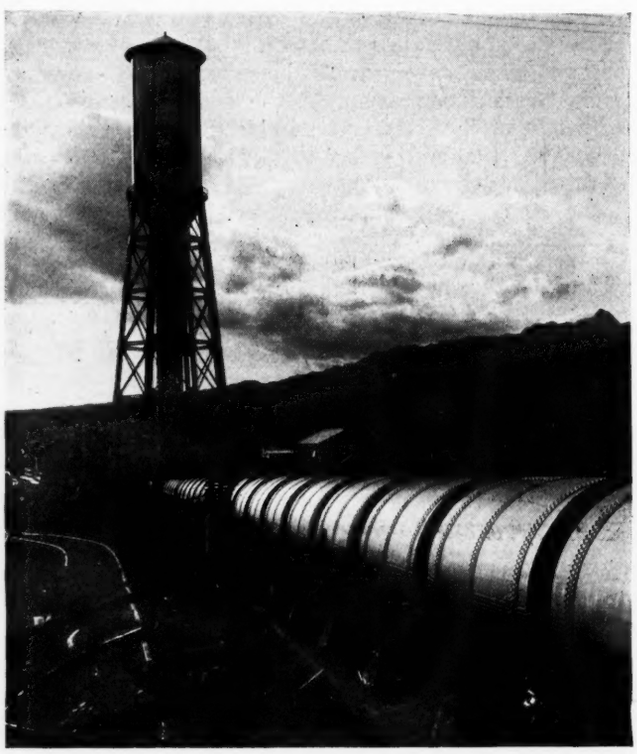


Fig. 4—Looking down the pressure conduit toward the surge tank above the power house

charges upward at the floor of the tailrace canal through a bell-mouth-shaped pipe eighteen feet in diameter.

Generating Units

There are three main turbines, of the vertical-shaft Francis type, built by the Allis-Chalmers Mfg. Co. Each turbine will develop 36,000 hp. at full gate under 390 ft. maximum net head at 300 r.p.m. and is suitable for operating under a minimum head of 358 ft. when the reservoir is at maximum drawdown and three units are in operation. The casings are of the circular-section plate-steel spiral type. The runners are made of cast steel and bolted to the turbine shafts. Above each runner is an automatically oil-lubricated babbitted, removable guide bearing, with labyrinth seal-type shaft packing box separating the lubricating oil of the bearing and the water above the runner crown.

The outside type of gate-operating mechanism was used and provided with a central shifting ring directly operated by two regulating cylinders mounted on the cast-iron portion of the supporting barrel. Plate-steel draft tubes were used to expedite the construction work of the subfoundation of the power house, also to give proper cross-section and to take care of the high discharge velocity. A butterfly valve of nine-foot inside diameter has been placed at each casing inlet. At the manifold are eleven-foot butterfly valves. The governor actuators are flyballs directly mounted on the turbine shaft. They are provided with a floating lever, double-acting pilot-type regulating valve, a relay compensating dashpot, a synchronizer arranged for motor control from the switchboard, with a gate-opening indicator at the switchboard. The service unit is of the horizontal impulse type, developing 450 hp. at 375 r.p.m. under a minimum head of 350 feet.

The three main generators are 28,000-kva. 11,000-volt 50-cycle 300-r.p.m. vertical-shaft Westinghouse machines with 140-kw. 250-volt direct-connected exciters. A 300-kva. 3,300-volt 50-cycle 375-r.p.m. 16-pole horizontal generator is coupled to the service unit and can be used as a synchronous motor driving the spare exciter.

Fig. 5—The tunnel is a horseshoe shape in cross-section and is 18.5 ft. high by 18.5 ft. wide

A two-circuit transmission tower line about two miles in length connects the Saku station with the 154-kv. transmission line of the Joyetsu system of the Tokio Electric Light Company, to which company the power is sold. It is expected that under certain conditions a generator at this plant might be required to charge the 130-mile Joyetsu system. In that event the generator would carry a 15,000-kva. load at leading power factor under no-load conditions. To insure stable operation, the saturation characteristics of the generators are designed to be below-the-line charging characteristics, and the generators can be satisfactorily operated under the conditions of field excitation for such service.

The low-tension switchgear comprises equipment suitable for supplying a transformer circuit of 84,000 kva. Owing to the use of three 28,000-kva. generators, it has been arranged to sectionalize the 11,000-volt busbars by disconnecting switches between each generator, to connect the local service transformer to the middle bus section and to connect each of the two end sections through disconnecting switches to an 11,000-volt transformer circuit of 84,000 kva. capacity. The main connections in the 11,000-volt circuits comprise three generators connecting through truck breakers and disconnecting to a single 11,000-volt bus. This bus supplies two outgoing 11,000-volt lines to the low-tension side of the step-up transformers.

Plant Service at 3,300 Volts

A bank of transformers for local service supplies power to a 3,300-volt bus. An auxiliary generator for local service and the spare exciter are connected to a waterwheel operating at 375 r.p.m. Provision has been made in the switching equipment for starting the 300-kva. generator as a synchronous motor by connecting to the taps on the 450-kva. transformer bank in an emergency.

Differential relays have been provided for the generators and the local service transformers. Provision has been made for differential protection between the 154-kv. side of the step-up transformers and the generator circuits, so that internal trouble in the main transformer will trip the line and generator breakers. A lockout relay for the local service transformers guards against immediate reclosure if the short circuit draws more than 36,000 amp. from the 11,000-volt bus. The 154-kv. high-tension switchgear was built by the Tokio Electric Light Company.

A Lux carbon-dioxide fire-extinguishing system with 26 cylinders has been provided. Thirteen of the cylinders manifolded together form the initial discharge; the other thirteen form the delayed discharge. The installation is made to act automatically by the action of the differential relay.

All hydraulic equipment for the power house was supplied by the Allis-Chalmers Manufacturing Company, the electrical equipment by the Westinghouse Electric & Manufacturing Company, the differential surge tank body by the Chicago Bridge & Iron Works, and the steel pressure conduit and penstocks and the structural steel frame for the surge tank by the Asano Shipyards.

Under K. Tsuruta, the writer, who had charge of the entire work, R. Nukushina had charge of the electrical engineering, and S. Shimodao of the civil engineering departments.

JOHN F. FERGUSON* ***Discusses***

BYPRODUCT POWER *from* PROCESS STEAM

IN INDUSTRIAL plants where steam or hot water is used in manufacturing processes or for heating all or a part of the power for the plant generally can be manufactured much cheaper than it can be purchased, except perhaps in such cases where the hours of operation are short or the additional labor cost is high in proportion to the power used. Power produced in this way becomes a byproduct of the manufacturing system and represents the cheapest class of power available from fuel. This power will compete favorably with hydroelectric energy almost anywhere in this country. The actual cost of such power under favorable conditions of load, fuel and operation may be compared with 24-hr. electrical service at $20 or less per horsepower per year.

For the generation of byproduct steam power, taking into account boiler plant prime mover and electric generator losses, the heat consumption in a high-class plant will be less than 5,000 B.t.u. per kw.-hr., corresponding to an over-all thermal efficiency of over 68 per cent and equivalent to about 0.35 lb. of coal per kw.-hr., costing 0.07c. on the basis of 14,000-B.t.u. coal at $4 per ton. In certain industries the trend seems to be toward a slightly greater increase in the use of power than of steam, proportionally with the increase in production, so that in the design of an industrial power system it is preferable to give considerable leeway, if possible, in the production of power from process steam. To meet future conditions this leeway may be gained by the use of higher steam pressures, lower exhaust or process steam pressures, or greater efficiency in prime movers and plant auxiliaries.

The gain by the use of high steam pressures is much greater in industrial plants where prime movers are operated against back pressure than in the case of plants operated condensing. The higher the work back pressure, the greater the gain in extreme pressures.

In industries where process steam is required at different pressures that generally are well established, the steam may be bled from different stages of expansion or at different exhaust pressures. Steam turbines or steam engines generally can be arranged to meet these different pressures, although special designs may be needed in some cases. As a rule, steam-engine units can be arranged for multiple and complicated bleeding and exhaust pressures more simply and efficiently than the turbine. The higher the initial pressure or the higher the working back pressure, the greater advantage the engine will have over the steam turbine. It is in the low-pressure range below atmosphere that the turbine will show better efficiency than the engine. The lower this range and the larger the unit, the more advantage the turbine will have. The reason for this is that the turbine is adapted to handle large volumes of steam at the low pressures, where the engine would require cylinders and valves too large to be efficiently operated. Above atmosphere these relatively large volumes are not encountered, so that the engine is superior in back-pressure service.

How much power can be generated per 1,000 lb. of steam expanding within any range from 3,200 lb. to atmospheric pressure by reciprocating engine or turbine is shown in a chart. Owing to their greater efficiencies under high pressure, it is predicted that the reciprocating machine as prime mover and boiler-feed pump will become the popular type of unit for industrial plants.

In some industries where there is a considerable variation in the steam demand during the day or during different seasons of the year, owing to plant operations or the heating of buildings, and the power demand does not follow in the same proportion, or where there is an exceptional peak power load without increased steam demand, a low-pressure turbine in combination with high-pressure, non-condensing engine units will work out to advantage. These conditions may not be of sufficient duration to justify going to extreme pressure to carry the maximum load under back-pressure operation alone. When the conditions of steam and power demand are favorable, the power load can be carried on prime movers exhausting to process or heating. During the unbalanced periods, with reduced steam demand or increased power load, or both, the low-pressure turbine can be brought into service. The process or heating systems will obtain the amount of steam required and the additional power load will be carried by the low-pressure turbine taking steam at exhaust pressure. The low-pressure turbine can float on the power load, governed by the steam available. In some plants the occasion to operate the low-pressure turbine may occur during the off-heating season only.

The amount of byproduct power that can be obtained in any industrial plant will depend upon the range of expansion, the initial steam pressure, the final or exhaust pressure used for process or heating, the layout of the steam plant and the class of equipment used. The higher the boiler pressure and the lower the terminal or exhaust pressure, the greater the range of expansion and the

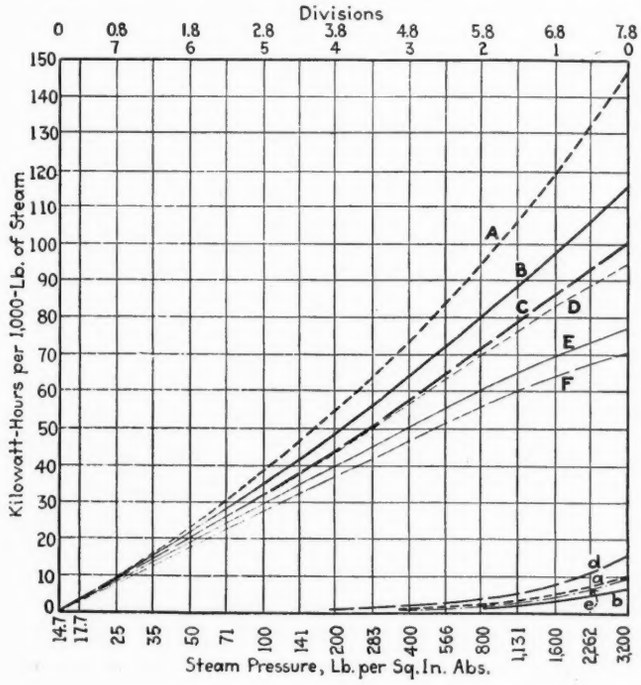
*Ferguson Engineers, Chicago.

more power available. In the chart are shown curves indicating the power that can be obtained when expanding within any range from the critical steam pressure of 3,200 lb. per sq.in. down to atmospheric pressure. These curves are intended for fair-sized industrial power units of about 2,000 kw. capacity and using around 40,000 lb. of steam per hour. The steam conditions are based on initial steam pressures at saturated steam temperatures, up to the point of maximum total heat content, and from this point up to 3,200 lb. a constant total heat content has been taken. Inasmuch as it is intended to consider here only the back-pressure operation generally encountered in industrial service, no attempt has been made to show results below atmospheric pressure. Absolute pressures have been used throughout.

Curves *A, B* and *C* are for reciprocating steam engines and curves *D, E* and *F* are for steam turbines, both of the highest class or of special design. The curves indicate the kilowatt-hours available per 1,000 lb. of dry or saturated steam delivered to process or to the heating system from the prime mover. Curves *a, b, d* and *e* represent the power required for boiler-feed pumps under the different power conditions.

Curve *B* indicates the amount of power available from engine units in expanding from any given pressure down to atmospheric relief when no steam is used from any of the stages for process or feed-water heating. This represents a system in which the exhaust steam of the prime mover is condensed and returned to the boiler, and any heating of the feed water is supplied from other sources of steam or heat.

For short ranges of expansion, not over 3 to 1, between initial and exhaust pressure, and for other than atmospheric exhaust pressure, the amount of power available will be the difference between the readings on



Byproduct power available from process and heating steam

curve *C* for engine units and curve *F* for turbine units, corresponding to the initial and terminal pressures. For example, when expanding from 400 to 200 lb., the power available from the engine will be 57 — 44 = 13 kw. per 1,000 lb. of exhaust steam, and from the turbine, 47 — 37 = 10 kilowatts.

Curve *A* indicates the power available from engine units, expanding from any given pressure down to atmospheric exhaust, when using stage feed-water heaters arranged in series, with an initial feed-water temperature equal to the final exhaust-steam temperature. This may represent a closed system in which all, or practically all, of the exhaust steam is condensed and returned to the feed-water system at or close to the exhaust temperature and further heated by feed-water heaters in series with steam bled from different stages of expansion.

To determine the power without stage heaters, with engine units having other than atmospheric exhaust pressure, read off the difference on curve *C* corresponding to the initial and exhaust pressures and add to this the difference in power in a vertical line between curves *B* and *C* measured at a point horizontally distant from the atmospheric line equal to the actual measurement on the chart between the initial and exhaust pressures. In making this measurement the divisions at the top of the chart will be of assistance.

Thus to find the power available from an engine unit in expanding from 800 to 100 lb. pressure, find from curve *C* the difference between the readings corresponding to 800 and 100 lb., 71 — 31.5 = 39.5 kilowatts.

The horizontal distance from the atmospheric line on the chart equal to the distance between 800 and 100 lb. will coincide with about 114 lb. At the intersections made by a vertical line through this point with curves *B* and *C* make the readings and find the difference, 37.5 — 34 = 3.5.

Then, 39.5 + 3.5 = 43 kw. per 1,000 lb. of steam at the exhaust pressure. For turbine units read off on curves *F* and *E*, respectively, with the following result, 56 — 27 + (34 — 31) = 32 kilowatts.

To determine the power available with stage feed-water heaters, use curve *A* for engine units and *D* for turbine units, instead of the curves *B* and *E* respectively, in the example.

With higher steam temperatures than have been considered, the power output would be increased slightly over the figures obtained from the chart. If the feed water is heated by the exhaust steam of the prime mover, from temperatures below that of the exhaust steam, as in the case of raw water from around 70 deg. F., then the power per 1,000 lb. of exhaust steam delivered to the manufacturing system would be increased accordingly in curves *A* and *D*.

Curves *a* and *b* in the lower corner of the chart represent the power required for boiler feed pumps of the plunger or piston type, corresponding, respectively, with the power output shown by curves *A* and *B*. Curves *d* and *e* represent the power required for boiler-feed pumps of the centrifugal type, corresponding to the power output in curves *D* and *E*. The pump curves are based on capacities of 40,000 to 80,000 lb. per hour or 80 to 160 gal. per minute.

It will be seen that the increase in power consumption for centrifugal pumps between 1,600 and 3,200 lb. working pressure is almost equal to the increase in power output from the steam in expanding from 3,200 down to 1,600 lb. pressure with the turbine unit. As a consequence, little net gain in power output can be expected in exceeding 1,600 lb. steam pressure with the industrial size of turbine units considered here. With reciprocat-

ing pumps and reciprocating power units there is still considerable gain with or without stage heating of feed water, in going above 1,600 lb. The amount of power available from the steam used in process as shown in the curves represents what can be accomplished rather than what is now being attained; first, because in general there are no units operating in the extreme pressure ranges, and, second, the curves are intended for units having extreme efficiencies that can be had but are not in general use.

The chart shows that the large amount of byproduct power obtainable from a given amount of process steam is not altogether dependent upon the initial and final pressures, but equally as much depends upon the type, class and arrangement of equipment. When expanding to atmospheric pressure, the engine unit will deliver as much power with an initial pressure of 500 lb. as the turbine will with 1,600 lb., as will be evident from curves *B* and *E;* or the engine unit, with stage heating of the feed water, will produce the same results with 350 lb. pressure as the turbine unit operating under 1,600 lb. but without stage heating of feed water. (See curves *A* and *E.*)

Again, using the power reciprocating pump and stage heating of feed water with the engine unit, and the centrifugal pump without stage heating of feed water with the turbine, the engine unit will produce approximately equal results with 375 lb. pressure as will the turbine installation with 3,200 lb. initial steam pressure.

Why go to extreme initial steam pressures in the boiler plant installation and then go down to the lower efficiencies in utilizing this pressure, as is the case with certain of the high-pressure plants now built or building.

Precautions to Be Observed When Grounding Electrical Equipment

By Robert Ball

TO BE effective a protective ground must be capable of safely carrying the current that would flow if the line were energized at normal voltage until it can be de-energized by relay action or otherwise. Unless this requirement is met, the grounding device is a source of danger. Should a grounding device fail, not only may severe burns result therefrom, but the line potential may rise to its normal value.

It is not difficult to construct stationary grounds that will safely carry any amount of current, but the carrying capacity of a portable grounding device is limited, because such a device must be light. Sufficient capacity can be obtained by using a number of portable grounding devices in multiple.

Stationary grounding devices should be installed at the circuit breakers or on switches intended to be used for isolating equipment or on a section of line. It should be possible to ground all equipment and the ends of sections of transmission lines without portable grounds, the use of which should be limited to such devices as are awkward to handle, dangerous to apply and costly to maintain. Where possible, stationary grounding devices should be provided with interlocks, so that energized equipment cannot be grounded through error, or equipment that is grounded be energized until after grounding and short-circuiting devices are removed.

However, it is not possible to make protective grounding a foolproof operation even when stationary grounds and interlocks alone are employed; and interlocks cannot be applied to portable grounding devices. The operations of grounding must be safeguarded by first testing for potential, then safely grounding the line that tested dead. Serious accidents have resulted from the failure to test for potential, from unsafe application of grounds, and from attempting to ground a live line.

After grounds are applied it is important that the fact be recorded on a suitable tag or card attached to the control switches of the circuit breakers from which the line can be energized. These serve to remind the operator that a dangerous condition exists. The ground tag supplements the log book entry.

Failure to Remove Grounds

It cannot be denied that the practice of protective grounding is hazardous to service. Not only is there a possibility of trouble occurring when grounds are applied, as mentioned above, but disturbances or interruptions to service have resulted from the failure to remove grounds before energizing equipment.

Neglect in removing grounds results from the failure to understand or execute an order, or to forgetfulness. Failure to remove grounds, regardless of the cause, is a serious matter, and can only be prevented by all concerned keeping constantly in mind that they must not be left on equipment that is to be energized.

Defective Ground Conductors

The importance of using conductors of liberal area for permanent ground connections to circuit breaker tanks, operating levers, switch frames, etc., cannot be too strongly emphasized. Grounds that are too small constitute a menace to life, particularly where suitable insulated platforms are not provided.

In one instance an 11-kv. switch not effectively grounded failed as it was opened. The man who opened the switch received a shock that made him unconscious, and only recovered his senses in time to escape from the fire caused by the failure of the switch.

In another case the failure of one unit in a bank of auto-transformers caused the destruction of ground conductors that were considered amply large. Fortunately, no one touched the lever of the circuit breaker associated with the auto-transformers or a fatality would probably have resulted.

Operation of Disconnectors

Many interruptions to service and fatal or serious accidents have resulted from the opening of loaded disconnectors. Disconnectors and associated circuit breakers should be interlocked to avoid the possibility of operating in the wrong sequence. But interlocks are not generally used, and in some cases their application is not feasible. The hazard can be reduced by providing sufficient space about disconnectors to enable the operator to save himself if the wrong disconnector is opened. Where gang-operated disconnectors are used, the operating lever or wheel should be located to insure the operator's safety under the worst conditions.

In some plants it is the practice to issue all orders for grounding or operating disconnectors in writing, and to have two operators, one to check the other, perform such operations. Unfortunately, these precautions do not eliminate mistakes, and unless two men are available because of other duties, the expense of checking switching operations is not justified.

The CENTRIFUGE in Oil Purification

By Walter B. Keighton
The Sharples Specialty Company

CENTRIFUGES have been in use for a number of years for the purification of used lubricating oils and it is hardly necessary to justify their use for this purpose. Adequate oil purification represents an actual money saving to the engine operator, and the best form of oil-purification device is justified to obtain the maximum money saving and the best purification at the same time.

High-speed centrifuges are constructed to purify dirty oils containing traces of water or dirty oils containing larger quantities of water, including emulsions. In the former case the centrifuge is operated as a "clarifier," discharging a single effluent, the purified oil. The dirt originally suspended in the oil is retained in the bowl or rotor of the centrifuge as a compact cake. In the other case, where water is present in relatively large quantities, the centrifuge is operated as a "separator," discharging two effluents, one the purified oil and the other the water, which usually carries with it some of the dirt. The same apparatus may be used as either clarifier or separator by making a simple adjustment requiring but a few minutes of the operator's time.

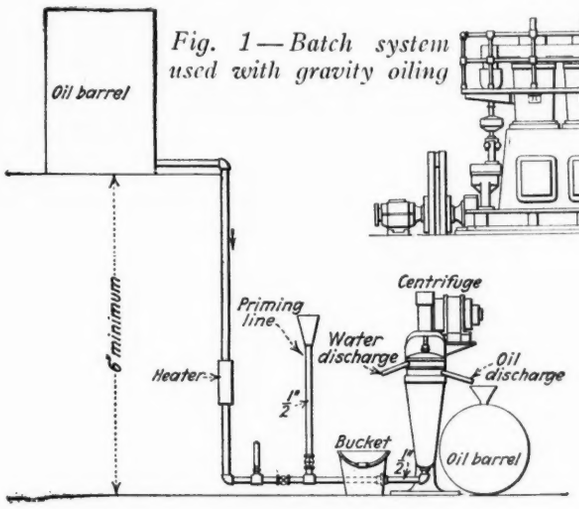


Fig. 1—Batch system used with gravity oiling

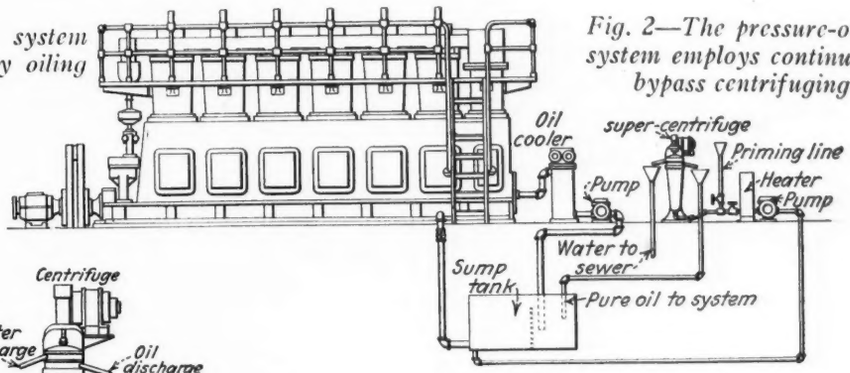


Fig. 2—The pressure-oiling system employs continuous-bypass centrifuging

The dirt retained in the rotor of the centrifuge should be cleaned out at regular intervals once or twice a day on most lubricating oil clarifications. In one make of centrifuge the rotor consists of only three parts, and weighs, when full of dirt, less than 50 lb. Thus it is easy to handle and easy to reassemble. With this type one may stop the centrifuge, remove the dirty rotor, replace it with a spare rotor and have the centrifuge in operation again within five minutes.

It should be noted that although the centrifuge separates water from oil it will not separate kerosene from oil. The water, being immiscible with the lubricating oil, is easily separated. The kerosene readily mixes with and dissolves in the lubricating oil, and is not separable. For similar reasons the centrifugal purification of a lubricating oil has no effect on its viscosity, or on its flash or fire points.

The centrifuge is not a filter, and is not subject to the same limitations as a filter. Filters are often inefficient in removing water and fine sediment from the oil. Where they do succeed, the filter medium rapidly becomes clogged and the capacity for filtering falls off. The filter medium absorbs oil, which must be thrown away when the filter medium is replaced. None of these things is true of the centrifuge, since it contains no filter medium and the removal of sediment and water is positive. Its capacity does not decrease as purification proceeds, as is the case with filters.

To obtain the best results with centrifuges, as with any other purifying apparatus, it is essential that they be correctly installed. There are two general systems of using centrifuges for oil purification, the batch system and the continuous bypass system. Where the lubricating system is so arranged that the oil passes through the engine but once, as when supplied by gravity sight feed or by mechanical force feed, the centrifuge is used on the batch system. The used oil is saved. When a sufficient amount has been accumulated the oil is centrifuged, using such an arrangement as shown in Fig. 1. The dirty oil is placed in the elevated barrel, and from it flows through a heater, where it is brought to a temperature of about 185 deg. F. It then flows to the centrifuge, where it is separated into purified oil (which is discharged to the oil barrel) and water (which is discarded).

Where the engine is lubricated by a pressure circulating system, the lubricating oil is purified by the continuous bypass method. This system is so arranged that a certain percentage of the oil is continuously passed through the centrifuge for purification. The centrifuge should handle the entire quantity of oil in the system once every two to six hours, depending on the kind of engine and its average load factor. Operating on the continuous bypass system, the centrifuge is connected to handle the dirtiest oil in the system. This is shown in Fig. 2, in which the feed to the centrifuge is taken from the bottom of the sump tank. The purified oil is returned to the other side of the sump tank. In this way the oil is always kept clean. Water and dirt are removed from it almost as rapidly as introduced.

An important point in the operation of centrifuges is the proper preparation of the oil for purification. This involves merely heating the oil and straining out coarse dirt, such as cotton waste, chips of wood or metal. Heating is not required for light non-viscous oils. The ease with which a suspended particle may be removed from the oil depends upon the viscosity of the oil. The more fluid the oil, the easier will the suspended particles settle out. An increase of from 30 to 40 deg. F. in temperature will usually double the rate of clarification. The oil may be heated by means of the hot exhaust gases, by bayonet-type electric heaters, or by steam heaters.

A Study of the INDUCTION TUBE *And Its Effect Upon* COMBUSTION

A simple, efficient and effective method of introducing overfire air into a boiler furnace to improve combustion and prevent smoke.

By H. Misostow
Engineer, Chicago Smoke Prevention Bureau

THE steam induction tube, used to promote more efficient combustion, is neither new nor old. It is not new because some of its prototypes have been in use almost since the first effort to improve combustion; it is not old because all of the information required for a complete understanding of its effect was not at hand until recently.

The art of heat production goes back to before history, but the science of quantity heat production at a uniform rate and at a desired temperature is modern. It was with this quantity heat production that trouble for the combustion engineer began. At first he turned to chemistry for the solution of his problem, but it soon became evident that more than the ordinary chemistry of combustion had to be mastered in order to deal intelligently with commercial combustion. This was particularly so when he was dealing with bituminous coal, of which volatile combustible matter forms such an important part.

It is a fundamental law of nature that solids, liquids and gases tend to assume and remain in their most stable form for their particular environment unless acted upon by some external force. In dealing with hydrocarbons we must expect the same tendency to resist change, and the formation of such new hydrocarbons as are best adapted to exist under given conditions.

Important factors that determine the changes in the hydrocarbons are the method of introducing the coal into the furnace, and the temperature above the coal bed before and after the coal begins participating in active oxidation. All mechanical stokers aim at a low-temperature distillation to obtain volatile hydrocarbons and a high-temperature combustion zone for the fixed carbon. Coal is moved from the outside temperature into the furnace temperature zone slowly, allowing time for gradual low-temperature distillation before combustion takes place. This idea prevails in chain-grate, side-feed and underfeed stokers. In furnaces that are hand-fired or equipped with overfeed stokers, the coal is subjected to the furnace heat at once, and distillation is naturally violent and destructive, and the resultant hydrocarbons are richer in carbon and more difficult to handle.

In a study of gases from the fuel bed, the United States Bureau of Mines (Bulletin No. 135) has given a number of interesting findings. One of the curves, dealing with the tar and soot contents of these gases according to the length of travel from the fuel bed, is reproduced in Fig. 1 to indicate what takes place in the furnace after it is charged with fresh fuel.

In the case of powdered coal, the foregoing difficulty is reduced, for the powder makes possible an explosive mixture. On being introduced into the furnace, where high temperature prevails, each particle of coal is heated instantaneously. The old combination of atoms is shattered by this change in environment and the rush to form a new arrangement better adapted to exist at furnace temperature begins. As such atoms are freed in the old combination, they are taken up by the free oxygen surrounding them, forming new stable gases. These new combinations of CO_2 and H_2O prevent the formation of free carbon stable at furnace temperatures.

This stage of combustion is the critical point. If the hydrocarbons are allowed, because of the absence of oxygen, to form a new combination of atoms stable at the furnace temperature, smoke is the result. To obtain rapid and complete oxidation it is necessary to prevent any re-formation of broken-up hydrocarbons into new combinations stable at furnace temperature by introducing oxygen at the time and place where decomposition of the original hydrocarbons begins.

This point, naturally, is determined by the method of supplying the fuel, but it is never very far from where the fresh fuel enters the furnace. The beginning of soot formation may be taken as indicative of the beginning of active decomposition of hydrocarbons, which occurs in the fuel bed or at its surface as soon as the hydrocarbons are volatilized from the fixed carbon. In case of the hand-fired fuel bed, soot formation increases to a distance about one foot above the fuel bed, and then gradually decreases to below the rate of soot destruction. An overfire air supply, then, should in this case be aimed at the point of maximum demand, about one foot above the fuel bed.

Next in importance to taking advantage of the effect of temperature on the hydrocarbons is the question of mixing and scrubbing. To oxidize the combustable gases completely, they must be brought into contact with oxygen. Now, if the oxygen and the combustible gases are moving in the same direction and at the same speed, there is slight chance for them to become diffused in the short time available. To promote a mixture of the two, it is desirable to break the uniformity of direction and to create a difference in the velocities of the two causes. This turbulence is usually obtained from a jet of expanding steam projected obliquely to the direction of the gases. Turbulence so created also acts as a scrubbing agent, tearing from the combustibles the oxidized surface that forms a protective coat and shields the material within from oxygen. This last feature is particularly

important when violent destructive distillation takes place and the liquid tarry globules and small particles of carbon are projected some distance from the fuel bed.

The amount of overfire or secondary air required should always be more than enough to oxidize all the combustibles, if combustion is to be complete. A controlled supply is desirable because it can be directed at the place where it will do the most good in the shortest time, thus reducing the amount of excess air required for complete commercial combustion.

Of the many methods of supplying air over the fire, the induction tube is one of the simplest, most efficient and economical, since the air drawn in is a byproduct in the process of introducing a catalyst, steam, to assist in the decomposition of the hydrocarbons. Any agent that promotes the rapid breaking up of the hydrocarbons in the presence of oxygen increases the rapidity of oxidation. Steam and refractory materials by their presence in the zone of combustion increase the speed of this decomposition, so the steam used in the induction tube performs a special service. Increasing the rapidity of the reaction a fraction of a second means a more complete combustion, which will return many times the loss of the heat in the steam flowing through the induction tube.

Several times "complete commercial combustion" has been mentioned with the intention of differentiating it from complete combustion, meaning oxidation of all combustibles. Complete commercial combustion means combustion carried to a point at which maximum heat from a given fuel can be made available. Completeness to which combustion can practically be carried varies with the conditions under which combustion occurs.

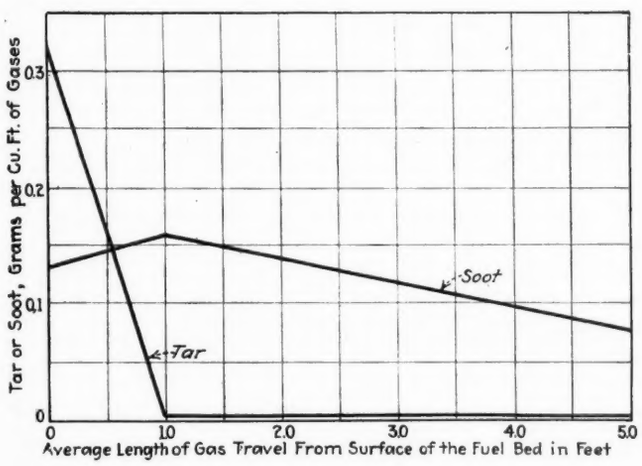


Fig. 1—Average of nine tests showing how soot tar formations decrease with the distance from the fuel bed

Under ideal conditions, commercial combustion will be complete. To approach this ideal in the furnace, there must be the greatest possible oxidation of combustibles with the least possible amount of air. The function of the induction tube is to secure this result. No less important than completeness of combustion is the fact that the prevention of soot formation results in the elimination of smoke.

Fig. 2 shows the location of induction tubes serving a chain-grate installation and a detail of the tube. It is not intended that this will be copied for all purposes, but that it will be used in the light of the information presented about the action of the induction tube. A few general rules can be followed with advantage to the novice in design.

1. Do not direct the nozzle at the brickwork unless the brickwork is intended to serve as a target to produce eddies and its destruction planned for, or unless the furnace is so wide that there is no chance for the current from the nozzle to reach the brickwork with any appreciable force.

2. Do not allow the center line of the nozzle to come in contact with the fuel bed.

3. The nozzle should be at such a distance from the discharge end of the outer tube that the steam from the nozzle and the air induced by the suction will form in

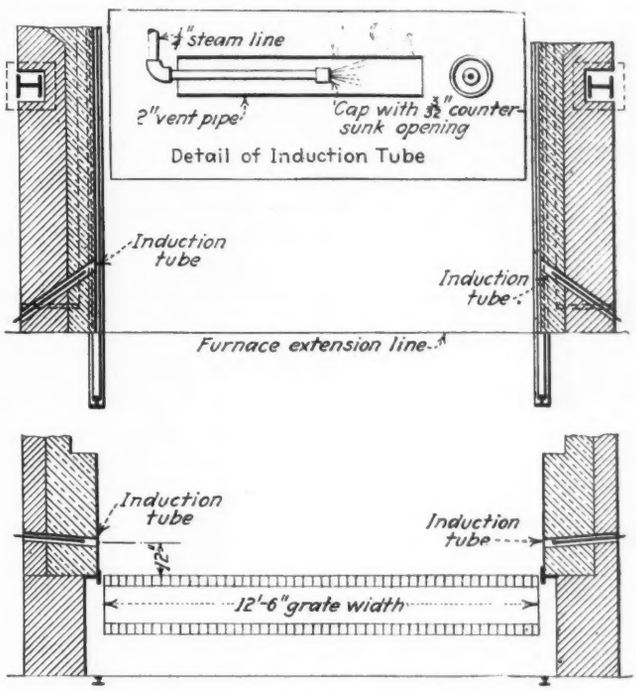


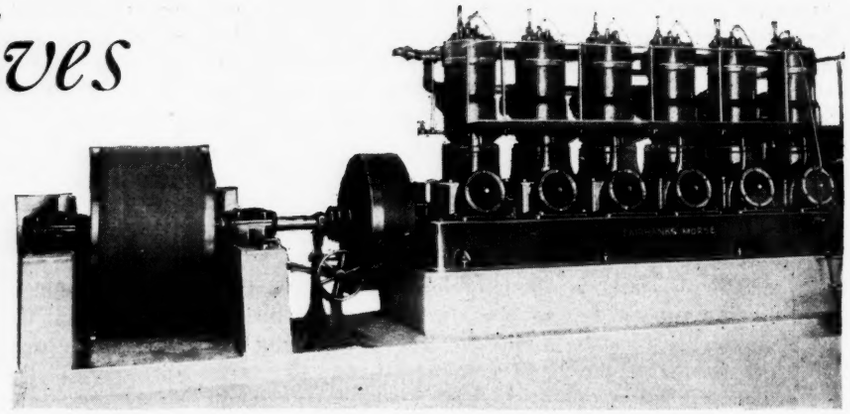
Fig. 2—Location of induction tubes serving a chain-grate installation and a detail of the tube

the outer tube a mixture of the same pressure before this mixture leaves the outer tube to enter the furnace proper. In case of a narrow furnace and high pressure or a short outer tube, some impediment may be provided in the outer tube to cause expansion of the steam a short distance from the nozzle and thus form a mixture in a much shorter time or distance than would be possible without that impediment. This may be a cone with a base diameter about one-half the diameter of the outer tube, and set so that the apex of the cone is in line with the nozzle, opposed to it, and from 3 to 5 in. away. This construction will also produce a Venturi effect and convert pressure head into velocity head almost instantaneously, making possible a desirable mixture in a short time.

A CORRECTION—In the table of equipment accompanying the description of the Riverbend Station, in the Sept. 3 number of *Power*, the evaporators were listed as having been furnished by the Elliott Company, instead of the Foster Wheeler Corporation.

Diesel Drives

Should Be Planned to Meet *Individual* FACTORY REQUIREMENTS



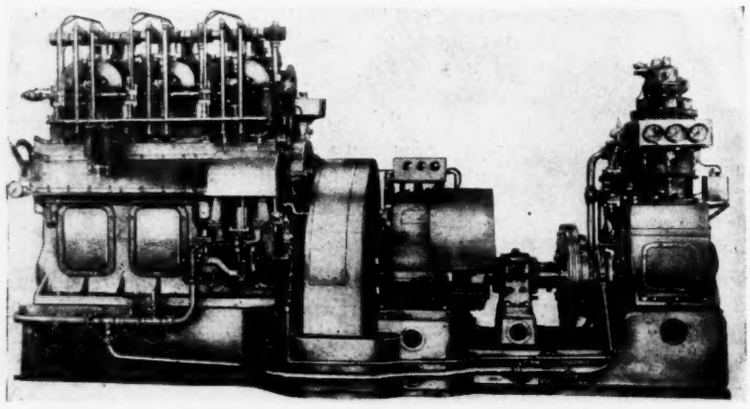
By L. A. Pease
Fairbanks, Morse & Co.

THE type of drive to be employed with any Diesel engine for stationary use is determined to a great extent by the requirements of the factory or mill. It is not always a problem of simply connecting the Diesel unit to a machine or shaft with a belt, for it may reach back into the method of the drive of the individual loads.

The manner of connecting the unit to its load may determine the connection of the various subdivisions of the load to the major drive, and this may be electrical equipment or by belt, rope or gear, depending upon many factors. A careful study of the characteristics of the whole load and the various subdivisions must be made when choosing drive from the prime mover. If all of the drives of the various units are settled, it is only necessary to handle the problem of connecting the prime mover to a single power-consuming point.

The major object is to install a drive that will serve the owner to his best interests. Many problems may be satisfactorily solved with one of several drives. A brief description will be given only of those in most common use for Diesel work, it being understood that it may be possible to take any one of several drives and make a satisfactory installation. A detailed description of the drives available with tables for application will not be attempted. A few general tabulations that will guide the reader in his general study will be set forth. Final recommendations are best made by one who is thoroughly conversant with all the local conditions.

Fig. 1—A Diesel engine using a magnetic type of clutch



Among the oldest forms of drives are the rope and the belt. They are still in use to a great extent today in Diesel plants, particularly for flour mills, cotton gins, dredging units and pumping plants, where the engine can be readily located near the load, and in capacities up to and including 400 hp. With most of the larger engines it is now becoming the common practice to use electric drives principally as a matter of convenience and flexibility.

Table I will serve as a guide for choosing belt widths of double belting and pulley sizes for various Diesel drives of from 50 to 400 hp. at engine speeds of 257 and 300 r.p.m. It is preferable to choose a high-grade tanned belt, made from center-stock leather and put together with a cement impervious to water. If other than this type of belt is used the maker should be held responsible for his recommendations.

When no tighteners or special drives are employed, it is customary to use pulleys with center spacing of from 25 to 30 ft., limiting the belt speed to 5,000 ft. per minute. Tightener pulleys are at times advisable in cases where the pulley center cannot be shifted to tighten the belt. They should be placed on the slack side, which is preferable to the top, and at about a quarter way from the driving pulley. Endless belts are to be preferred although laced belts are used in many cases. Normal tension with the belt at rest on drives of this type should be about 240 lb. per square inch of belt cross-section. For special application the manufacturer's recommendation should be followed. The life of a first-class leather belt is from eight years upward, depending on the many conditions surrounding its choice, maintenance and operation. Table I includes pulley data as used with a well-known line of Diesel engines.

Where the load is easy to start, such as with centrifugal pumps, electric generators or types of compressors where the cylinders contain ample relief valves, the engine can be directly connected or belted directly to the load. However, where the load is hard

to start—as in case of flour mills or plants with long line shafts, or where processing may give a static load of considerable proportion—a clutch, either friction or electric, should be used. A flour mill, for instance, has a starting load approximately 2½ times its full-load torque.

The employment of a friction clutch for direct-shaft drive is shown in Fig. 4; this is suitable for engines up to 265 hp. A clutch arrangement for belt drive for engines of from 100 to 400 hp., inclusive, is shown in Fig. 5. This arrangement has the clutch ring bolted to the flywheel face, while the clutch spider is keyed to

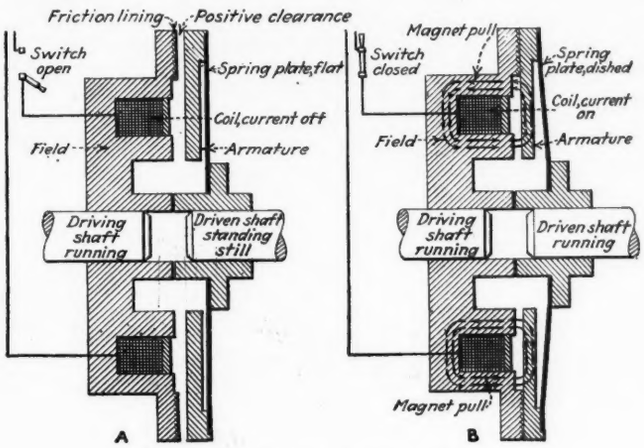


Fig. 2—Action of a magnetic clutch

an extention shaft, which also carries the driving pulley. All of these mechanisms are operated from a stand bolted to the floor adjacent to the clutch mechanism.

Large belt drives can be satisfactorily arranged when installed, as is shown in the picture at the top of this article, it being a 360-hp. Diesel drive used by the Picher Lead Company, Amodo, Ariz., where a clutch coupling and driving pulley is located on an extension shaft. As shown in detail in Fig. 5, this engine employs a 66 x 42-in. pulley driven through a 48-in. 6-arm friction clutch.

When the service is particularly severe and starting of the load is frequent it is good practice to use electromagnetic clutches. In choosing these clutches one must be sure they are suitable for the service, and the clutch manufacturer should always be consulted before making final recommendations for a difficult application.

Table II gives the rating of magnetic clutches applicable to Diesel-engine service. It is based on normal duties, such as pump drives. There are many applications where the clutch required may be heavier. This table, however, will serve to indicate the equipment necessary for normal service.

The magnetic clutch is a friction mechanism in which the friction surfaces are held together by the direct pull of an electromagnet, instead of by lever arms, manually actuated, as in the case of the usual friction clutch.

The principal parts of one make of magnetic clutch are given in Fig. 2. The armature is a steel casting attached to the driven shaft by a spring-steel plate riveted to the driving hub. The field, containing the electromagnet and friction lining, is carried on the driving shaft. The coil is energized by direct current from some convenient source carried to the clutch through two collector rings mounted on the driving shaft.

When de-energized the armature and field are separated by a running clearance, as shown at *A* Fig. 2, and the driven shaft may rotate freely and independently of the other equipment. When the proper current is applied to the field circuit the armature is drawn over to it, dishing the armature plate and causing the outer rim of the armature to come in contact with the friction lining of the field member. The two parts are then locked together electrically, as shown at *B*, Fig. 2. A breaking of the electric circuit permits the armature face to return to its normal idle position.

Electric control of the clutch permits placing the engaging or disengaging buttons at any location. By inserting resistance in the control circuit the clutch capacity may be lowered, permitting the clutch to slip at any predetermined load, thereby preventing transmission of severe shocks to the driving unit.

A typical installation using a magnetic clutch with a Diesel engine appears in Fig. 1. The engine drives a direct current generator, with the armature mounted on the extension shaft, and a compressor connected through a magnetic clutch. This permits considerable flexibility, as either or both of the driven units may be put into or out of service by merely actuating an electric switch.

Where space will not permit long belt centers and where direct drive is not feasible, it is still possible to use a belt drive, with quite short pulley spacing, with a drive such as the Lenix, Fig. 3. This gives sufficient belt friction by wrapping the belt around more than 180 deg. of contact on both pulleys; at the same time it causes only a slight tension on the slack side of the belt. Belt stretch is automatically taken up, and it is not necessary to stop for adjustment.

When a specific installation embodying a difficult drive is to be made it is always well to refer to the maker of the drive, giving complete data, to insure a reliable installation.

The speed-changing gear has been developed to a high degree, and is very reliable and efficient. It may be obtained in most any size for Diesel use, and is installed in many plants for pumping, for fire service and for special machines, and is also quite widely used for driving ships' propellors. They are usually of the herringbone-gear type. The speed ratio range is quite wide, from 3 to 1 to as high as 15 to 1. Gears may be run in either direction and up to 5,000 revolutions per minute.

The endless rope drive is one of the earlest types but is not used much in Diesel service. It is becoming more

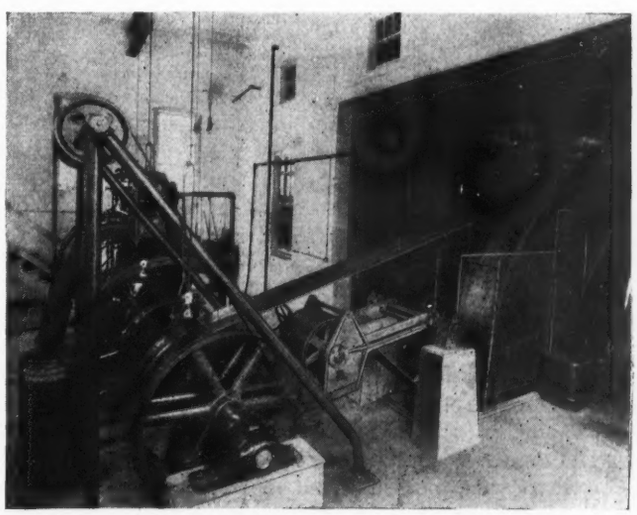


Fig. 3—A short center drive may be necessary

common practice to use the multiple V-type drive.

Where this is contemplated, the belt maker should be given all available data on both driven and driving equipment, so that suitable equipment may be furnished and satisfactory service performed.

The electric drive is quite advantageous where the load is widely distributed, and is quite necessary where the area covered is extensive or the load heavy. The generator capacity can be subdivided to be well loaded at all times, even though only a part of the load-consuming plant is in operation. It is the most flexible drive and is now in general use. Its extreme flexibility permits a plant with as low as 33 per cent annual load factor to be operated at a high engine economy.

If the load is motorized, in a plant under consideration, or it is desired to use motors in a new layout, the distribution voltage will have to be determined. This is usually 220 to 440 volts, 3 phase, 60 cycle. If the power plant is quite near, the motor voltage can be retained as the generator voltage. If the loss from the generator to the load at the motors is greater than 10 per cent, it will be well, particularly if the center of distribution is over 1,500 ft., to use a higher voltage for the main lines and to step down with transformers for secondary distribution mains. The next standard voltage would be 2,300, 3 phase, 60 cycle, which is usually adequate for any industrial plant. If longer distances are to be covered, it can be increased to 6,600, 13,200 or even 33,000 volts.

The electric drive is applicable to almost every type of installation. Considering that there is a generator and a motor, loss must be taken into consideration, it will be found that in many cases this loss is smaller than the mechanical loss of direct drive where long line shafts or many belts are used. Also electric drive is convenient, in that motors may be shifted from place to place or may be changed as the load comes on or off in different seasons.

A typical problem for belt drive is that of connecting a Diesel unit of 400 hp. to a flour mill that is now operating from a line shaft driven from a 350-hp. waterwheel belted to a common shaft driving the entire mill. The engine is to be used during low water and at times when the water equipment is not available. It would be well to visit the plant and make an accurate layout of the pulleys, shafting and belts, together with the building and equipment immediately surrounding the location of the new unit. This layout should be made in just as much detail as possible, so that a careful study of the many types of installations can be accurately laid out and the most effective drive chosen. It will be found after visiting the plant and making the layout that unless every object, such as posts, walls and pits, is given, it is probable that a drive may be chosen that will in some way interfere with the building or with mechanical equipment; on the other hand, if the preliminary work is carefully done, a first-class layout can be made without alterations on the job.

The layout may be begun with a simple belt drive, or, possibly, with the line shaft directly coupled to the engine through a friction or magnetic clutch. If the driven shaft's speed is near the engine speed and it is convenient to locate the engine at the end of the shaft, a layout showing this arrangement should be made. If this is not possible, a standard belt drive, if space is available, or a short-center drive, if the belt centers are close, should be chosen. If none of these arrangements is suitable, a motor-drive layout should be made, and the Diesel plant located where space is available.

In these arrangements adequate room for the auxiliaries and for maintenance and operation of the main units should be provided.

Fig. 4—Direct-connected shaft with a friction clutch

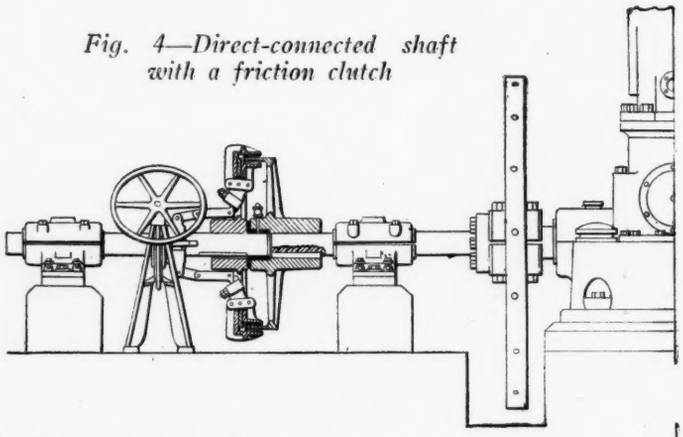


Fig. 5—The belt wheel is placed on an extension shaft

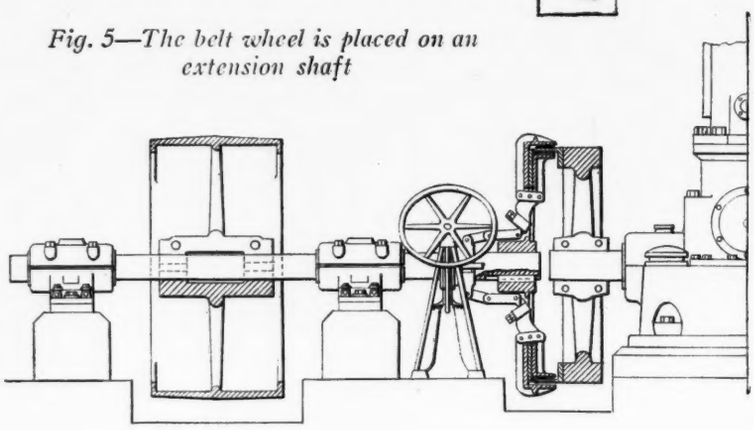
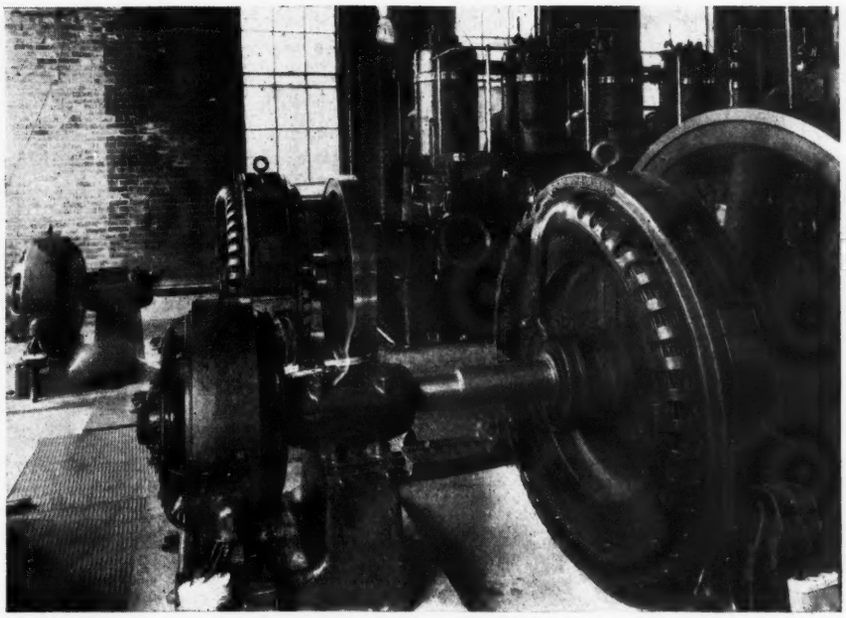


TABLE I— BELT WIDTHS AND NORMAL PULLEY SIZES

Engine Hp.	Engine Speed, R.p.m.	Driving Diam., In.	Pulley Face, In.	Belt Width, In.	Belt Speed, Ft. per Min
50	300	44	17	16	3,400
and		48	15	14	3,700
100		54	15	14	4,200
		60	15	14	4,700
65	257	50	22	20	3,300
and		54	22	20	3,600
150		60	22	20	4,000
		66	20	18	4,400
		72	20	18	4,800
200	257	54	28	26	3,600
		60	22	20	4,000
		66	20	18	4,400
		72	20	18	4,800
265	257	60	28	26	4,000
		66	28	26	4,400
400	257	60	42	40	4,000

TABLE II—MAGNETIC CLUTCH DATA

Engine Hp.	Engine R.p.m.	Size of Clutch, In.	Pull-Out Torque, Lb. Ft.	Amperes at 115 Volt	Amperes at 230 Volt
50	300	24	2,460	2.4	1.4
65	257	28	3,920	3.2	1.8
100	300	32	4,150	3.2	1.8
130	257	36	6,300	2.6	1.8
200	257	40	9,000	4.8	2.6
265	257	44	11,900	4.4	1.8
400	257	54	21,800	5.5	2.9
560	257	60	31,200	11.4	5.8
700	257	66	31,900	11.4	5.8
840	257	72	42,800	14.0	7.3
980	257	72	42,800	14.0	7.3



If the exciter's voltage is suddenly decreased, the induced voltage in the alternator's field coils may reverse the polarity of the exciter.

Why D.-C. Generators Reverse Polarity

By M. E. WAGNER
New York City

DIRECT-CURRENT generators under certain operating conditions may have the polarity of their field poles reversed. The cause of reverse polarity is generally due to a reverse current running through the machine. This reverse current may be produced in a number of ways, depending on the service supplied by the generator and on the operating conditions.

It is common practice to operate two or more generators in parallel. When taking a machine out of service that is operating in parallel with other machines its voltage is reduced until the load is practically all transferred to the other machines. When this condition is approached the circuit-breaker is tripped to disconnect the machine from the busbars. If the voltage is reduced too much when taking the machine off the line a reverse current will flow through the generator and will quickly reach a value that will trip the circuit breaker and may reverse the polarity of the field poles.

Why reverse polarity may occur under the foregoing conditions will be made clear by considering Figs. 1 and 2. In Fig. 1 it is assumed that both machines are delivering power to the load, and it will be seen that the current flows in the same direction in the series and the shunt field coils, which is the normal condition. Suppose that in taking machine *A* off the line its voltage is reduced to where all the load is transferred to machine *B* and that current flows from *B* to *A*, as in Fig. 2. Machine *B* will then tend to operate machine *A* as a motor.

Checking up on the direction of the current in the field coils of machine *A*, it will be observed that the current has been reversed in the series winding from what is was in Fig. 1. This makes the series and shunt coils oppose each other and tend to weaken the field in the polepieces. Weakening the fields of a motor tends to produce an increase in speed. This is what would happen to machine *A* if it took power from the busbars. When it tends to increase in speed, the mechanical load is increased on the machine, due to accelerating the heavy moving parts of the engine, and the generator takes a greater current from the other machine. Increasing the current through the series field winding acts to further increase the speed of the machine and to draw more current from the busbars.

This building up of the current in the generator operating as a motor occurs so quickly that it reaches a value that will trip the circuit breaker almost instantaneously. The current in the series winding may reach a value that will make the field produced by it greater than that of the shunt winding and reverse the polarity of the polepieces. The conditions under which this happens are favorable for the

The causes of direct-current generators reversing their polarity are outlined and explanations are given of how a generator's polarity may be reversed and how to proceed to correct the trouble and avoid its recurrence.

series winding reversing the polarity of the field poles, because the current in the shunt winding has been reduced by the rheostat. There is also a tendency to reduce the voltage at the machine by the increasing load on the generator operating as a motor. For these reasons a compound generator that has been allowed to trip off the busbars by reverse current is likely to have its polarity reversed.

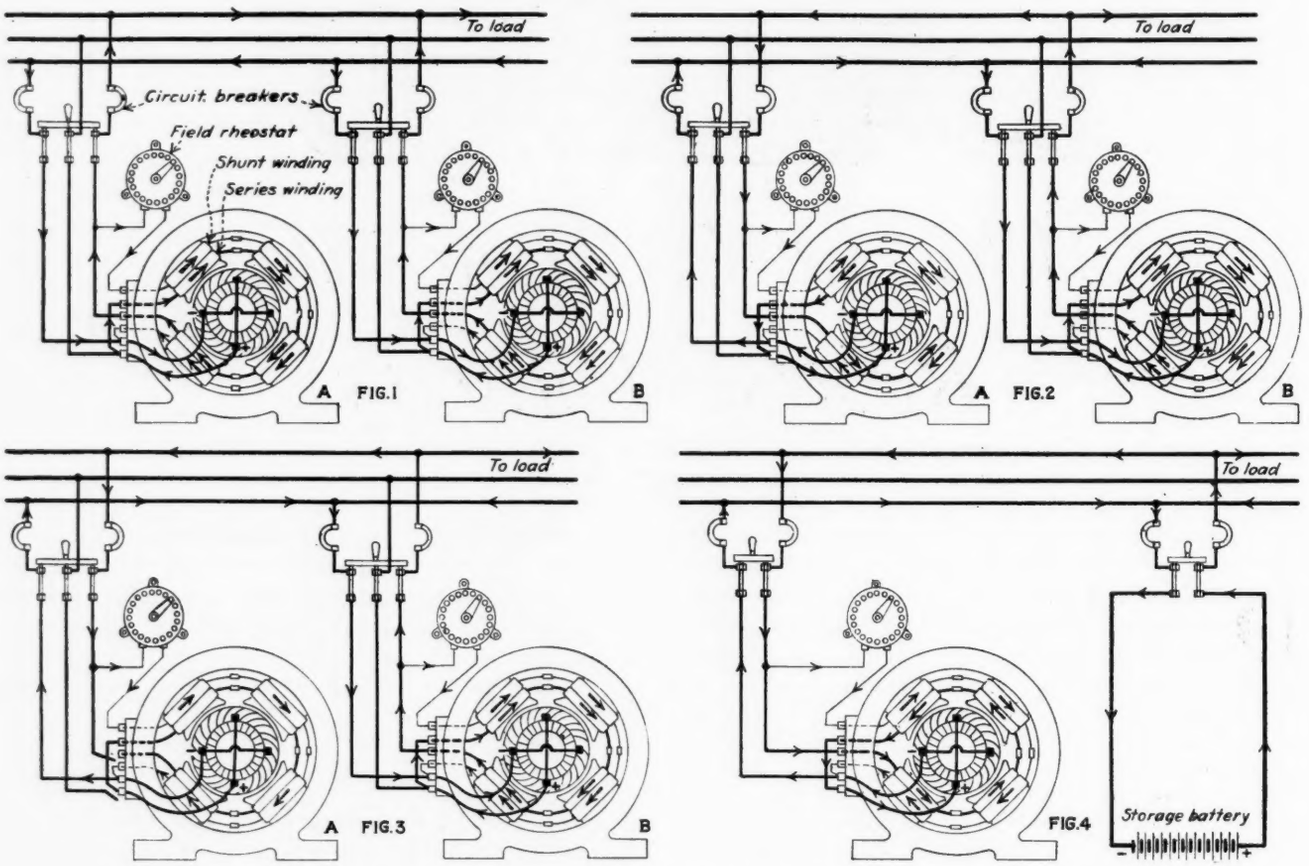
Reversed polarity of a generator is corrected by passing a current through the shunt field winding in a direction to produce the correct polarity in the field poles. When the shunt field coils are disconnected and energized from an outside circuit, they may be excited and the machine started slowly until a deflection is obtained on the voltmeter. If the voltmeter needle moves in the right direction it will be known that the correct polarity has been established. The machine may then be shut down, the outside excitation disconnected and the shunt field coil connections made as originally.

Should the voltage come up to the wrong polarity, as would be indicated by the voltmeter needle being deflected backward off the scale, the source of excitation should be disconnected from the shunt coils and the leads interchanged. This will reverse the direction of the current in the coils and, consequently, their polarity. After this has been done the machine can be put back into service as previously explained.

A better method of reversing the polarity of the machine, but one that must be used with care, is shown in Fig. 3. The equalizer and the armature lead, to which the field rheostat connects, are disconnected at the machine as indicated in the figure. After this has been done the circuit breaker and the switch are closed. This connects the shunt coils to the busbars correctly for a current to flow through them to give the right polarity. Before opening the switch the field rheostat should be turned to the position to put all the resistance in the field circuit. This allows breaking a minimum field current on the switch. When the switch has been opened the machine can be connected up again and started, when the polarity will be found correct.

What has been shown to cause reverse polarity of a compound generator when taking it out of service is also the cause of reverse polarity when a compound generator is charging a storage battery. If the voltage of the generator is allowed to drop below that of the battery, a reverse current will flow through the generator, as in Fig. 4. This current produces a reverse polarity in the series coils and will have the same effect as explained for Fig. 2. The polarity can be corrected by opening the armature circuit and closing the switches to connect the battery to the machine. This will cause a current to flow in the shunt field winding to give the correct polarity.

A compound generator used for charging a storage battery had its polarity reversed every few days. This generator was driven by a motor. When the cause of the trouble was run down it was found that the attendant who charged the battery would, when he took the battery off charge, open the motor switch and let the machine slow down. When the speed dropped to where the generator's voltage was less than that of the battery a re-



Figs. 1 to 4—Diagrams of compound generators connected in parallel

Fig. 1 shows the direction of current for normal operation of two compound generators in parallel. Fig. 2 shows the generator *B* has motorized generator *A*. Fig. 3 shows the field coils of generator *A* are being excited from generator *B*. Fig. 4 shows the generator is being motorized by the storage battery.

verse current flowed through the generator and tripped its circuit breaker. The reverse current reversed the polarity of the generator.

This trouble was overcome by instructing the attendant to operate the machine properly. Part of these instructions was to trip the circuit breaker on the generator before shutting down the motor and not to close the circuit breaker on the generator until its voltage was slightly higher than that of the battery.

When a compound generator is supplying power to a load that has high inertia, such as motor-driven machines that have heavy flywheels, it is possible for the load to reverse the polarity of the generator. This can be done by suddenly cutting the steam off the engine when the generator switch is closed. One case of this was where the governor rod on a Corliss engine unhooked and allowed the engine to slow down. Before the engine stopped the engineer put the valve mechanism into operation again and the unit came up to speed.

On going to the switchboard the voltmeter was found with its needle deflected backward off the scale, indicating that the generator's polarity had been reversed. This was caused by the generator slowing down more quickly than the motors. The counter voltage of the motors then became greater than the applied voltage and the motors supplied a current to the generator.

Fig. 5 shows the conditions for normal operation of the generator and the motor load. Operation after the engine slowed down is indicated in Fig. 6. Here it will be seen that the current has been reversed in the generator's series field winding. The reverse current through the series winding will tend to reduce the field pole flux and cause the generator's voltage to fall off rapidly. As a result, the reverse current builds up quickly and reaches a value where the series winding ampere turns become

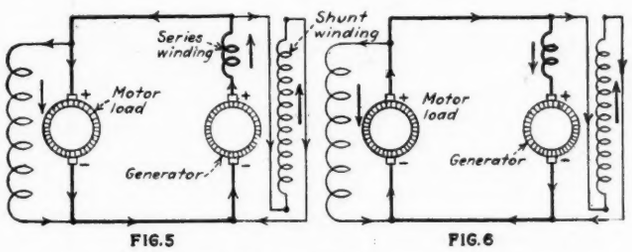


FIG.5 FIG.6

Figs. 5 and 6—Diagram of generator connected to motor load

Fig. 5—Arrows indicate direction of current when the generator supplies power to the motor load. Fig. 6—Arrows indicate flow of current when the motor load supplies power to the generator.

greater than the shunt winding's, and the polarity of the field poles is reversed.

Repeating the operation would correct the polarity. That is, when the machine was again operating at normal speed and load, the valve gear could be unhooked and the engine allowed to slow down quickly. The reverse current would again reverse the polarity and make it correct. Where there is one generator on the system and the load consists of motors and lights, the polarity of the generator need not be corrected. Changing the voltmeter and ammeter connections to make them read correctly is all that is necessary. A wattmeter on the system will read correctly for either polarity of the lines.

The causes for reverse polarity of compound generators given in the foregoing do not apply to shunt generators. A reverse current supplied to a shunt generator will cause it to operate as a motor at normal speed. If two shunt generators were operating in parallel and one machine's voltage was reduced to where the other machine took all the load and supplied power to it, the machine without generator load would operate as a motor to drive its prime mover. No bad effects would develop unless the voltage of the machine were reduced to where it would take a current large enough to overload the generator and trip the circuit breaker.

There are conditions under which a shunt generator may have its polarity reversed. One of these is when the machine is used as an individual exciter on an alternating-current generator. If the voltage of the exciter is reduced suddenly, such as might occur if the rheostat

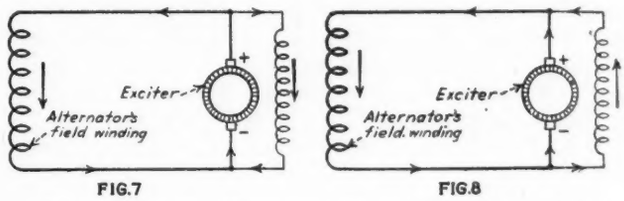


FIG.7 FIG.8

Figs. 7 and 8—Diagram of exciter connected to alternator's field winding

Fig. 7—Arrows show direction of current when the exciter supplies power to the alternator's field winding. Fig. 8—Arrows show direction of current when the alternator's field winding supplies power to the exciter.

was cut into the circuit quickly, there is the possibility of the alternator's fields maintaining a higher voltage than that produced by the exciter and reversing its polarity.

Fig. 7 is a simplified diagram of a shunt exciter connected to the field coils of an alternator. For normal operation the arrows show the direction of the current. When there is a change in the value of the current in the field coils a voltage is induced in them that tends to oppose the current change. For example, if the current decreases, a voltage is induced in the coils that acts to maintain the current in the circuit.

If in Fig. 7 the voltage of the exciter were to be suddenly reduced, the current would tend to decrease in proportion to the voltage. When the current started to decrease in the alternator's field coils these coils would have a voltage induced in them to maintain the current. It is possible under these conditions for the exciter's voltage to drop faster than the induced voltage in the alternator's field coils. Under such conditions the alternator's field coils would supply a current to the exciter, as indicated in Fig. 8. A comparison of Figs. 7 and 8 shows that the direction of the current has been reversed through the field coils of the exciter. This action would cause the polarity of the exciter's field poles to be reversed.

Opening of the exciter's field circuit would allow the voltage to drop to zero, but for a short period the induced voltage in the alternator's field coils would maintain a current in the circuit. This current flowing through the exciter's armature might reverse the polarity of its field pole. If the brushes on the exciter are set ahead of the neutral, the magnetic poles of the armature will oppose the main poles and, under such condition as just referred to, may reverse their polarity. Reversal of field polarity sometimes occurs from this cause, also when a heavy overload occurs on the machine. If the brushes are ahead of the neutral, the armature field poles may become of sufficient strength, even if the shunt coils are connected, to reverse the polarity of the pole-pieces.

Definite System of Stores Keeping Cuts Power Plant Costs

By Walter N. Polakov*
Consulting Engineer, New York City

THE power house is a large consumer of various stores and supplies. To draw them, when and as needed, from the general stores of the mill would sometimes involve considerable waste of time and much inconvenience. Frequently, therefore, a considerable quantity of special power house stores is kept on the premises, but often there is no definitely organized practice in receiving stores, issuing and pricing them.

In order to exercise full control of such sub-stores, a definite practice is needed, and the same is recommended in the following instruction.

The practice described embodies all essentials of modern stores keeping and will not conflict with any proper system. It is simple, and yet will satisfy all basic requirements.

The practice of "physical division" is of particular importance in the case of power plant stores, inasmuch as the oversight of "minimum quantity" or "order point" may cause shortage of articles which will allow no substitution. On the other hand, a considerable amount of stores used in the power plant are subject to deterioration with age, such as rubber articles, chemical reagents, certain gaskets, etc. Therefore, rigid observance of "amount to order" and of physical separation of minimum quantities and strict obedience to the rule of using up previous supplies before a new batch is started is important. This practice is productive of economy, safety and uninterrupted operation.

Sub-Stores

The purpose of a sub-store is to have on hand when needed all material needed and, at the same time, to see that:

1. All material not needed is disposed of.
2. All material is kept safely.
3. All material issued is properly charged.
4. All accounts are kept accurately.

Sub-Stores Articles: Bulky and frequently used articles such as coal, boiler tubes, gaskets, packing, lubricants, fuel oil, fuses, boiler compound, etc., after being purchased on an engineering specification, are checked and O.K'd by the storekeeper and immediately issued to the chief engineer for keeping in his custody.

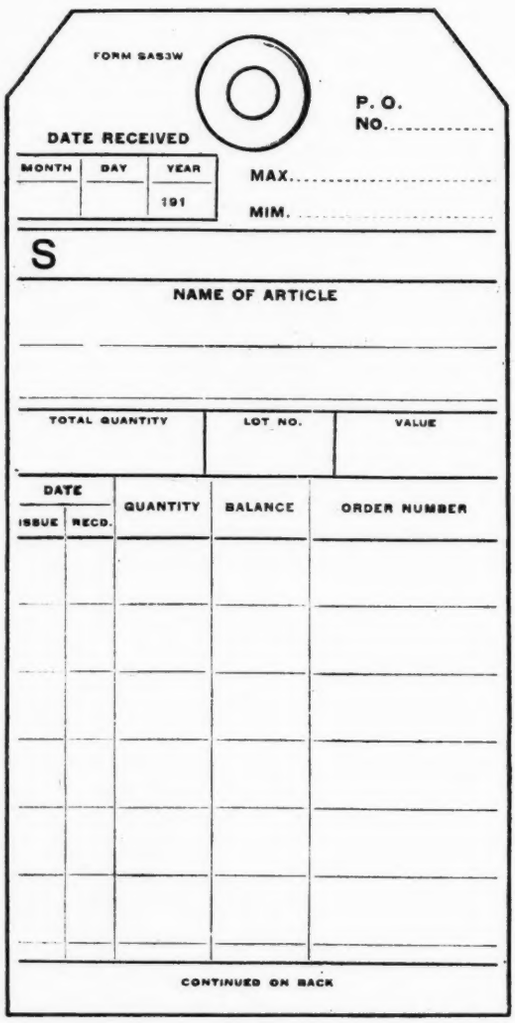
Large lots of such stores may be split and only a running supply issued to the power department. Similarly, stores of general use throughout the mill but frequently wanted in the power plant are issued by the storekeeper to the chief engineer for a running supply in his sub-store.

Responsibility: The chief engineer or power plant clerk will be custodian of all power sub-stores and be responsible for correct keeping of records. He shall have the authority to issue stores for the work under his supervision and request issue of stores to the sub-store from the general storekeeper.

If issues from the power plant sub-stores be made for use outside the power department, it is done only upon receipt of properly signed store issue card.

Stores Issues: Every issue of stores must be covered by a stores issue card or slip and these slips must contain the date and operating charge symbol or repair order number. Stores from the power plant sub-store will be issued only by the chief engineer, watch engineers or power plant clerk. Stores that are not available in power plant sub-stores must be secured upon presentation of a stores issue slip from the general stores; all slips must bear the signature of the chief engineer or the watch engineer (at night only). Stores issue slips are made in duplicate if issues are to be made from outside; if issues are made from the power plant sub-store a duplicate is not needed. All stores issue slips or their copies are kept on file until they are distributed monthly to expense accounts. Then they are returned to the general storekeeper to balance stores and sub-stores.

Bin Tag: A stores tag is attached to every bin o-



Bin tag used on supplies in power plant sub-stores

*All rights for republication or other use retained by Walter N. Polakov.

shelf containing one kind of stores. It identifies the material by stores symbol S——.

Description: When a new batch of materials is received, the tag is filled out on identification side showing:

On top:

Order No.
Amount ordered
Date
Location

On Bottom:

Order point (minimum quantity) (i.e., such quantity which, when reached, calls for ordering new supply. It is so determined that it would last as long as it takes to receive a new supply).

Amount to Order—(i.e., the quantity to be ordered at one time. It is so determined that in buying this quantity purchasing price and delivery advantages are secured, yet it is not too big to tie up much money, occupy much space or get spoiled before it is used up).

Time for Delivery—(Showing number of days it takes normally to get new supply).

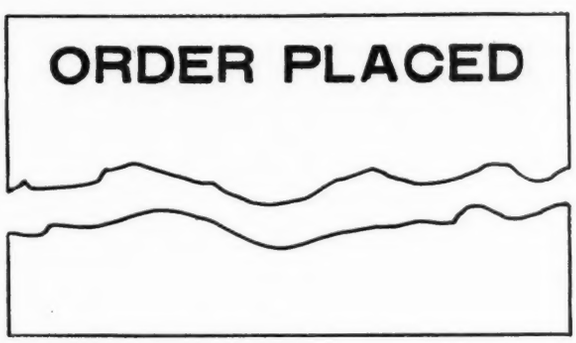
New Requisition—(i.e., the number or date of requisition calling for new supply or, if it is drawn from general stores, the number or date of stores issue slip calling for stores).

Balance of Stores: The back of this tag shall be so ruled that when each issue is entered, it is subtracted from the previous balance and the true balance on hand is always shown and corresponds to actual inventory, thus for instance:

Date	Issue	Balance
11/10/23	..	100
11/21/23	5	95
11/29/23	10	85
1/2/24	4	81

Ordering Stores: When a new supply is drawn from the general stores it is obtained by a stores issue slip. If it is not available at once, a red card marked "order placed" is placed in the bin as a reminder, and as soon as the new supply is received and is placed in the bin the red card is removed.

When a new supply is requisitioned directly by the chief engineer, the tag is removed and sent to the stores keeper for identification of the article wanted, and the red card is placed on the bin instead. *All* data from the tag are then transcribed on the red card and the balance of the remaining stores is kept on the back of this card.



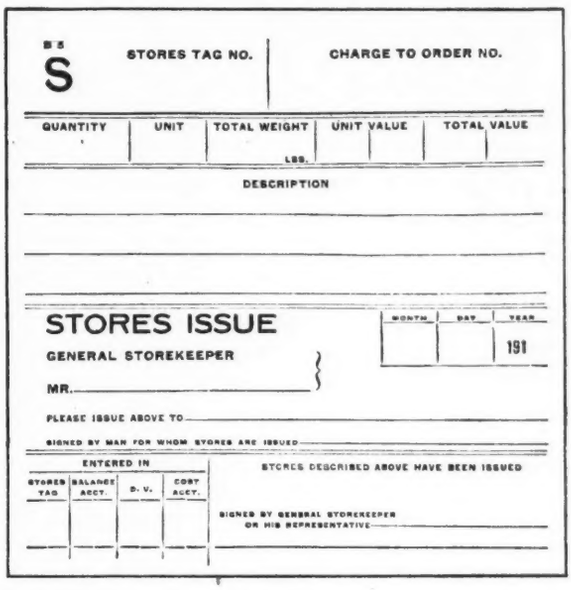
Red card used as signal in store room bins

When the new supply is received, a new tag is made, data transcribed on it and "order point" quantity is separated from issuing supply.

Physical Separation: All stores placed in bins or shelves must be physically separated, dividing the "order point" from the rest of the material. For this purpose a piece of wire with red tag on it is used, or red tape with which to tie up the minimum quantity, and no issue is made from this separated batch until all other supplies of this store are exhausted. This serves as protection against running short on any article.

When the tape is broken and the minimum quantity is ready for issue, the new requisition for this material (or stores issue, as the case may be) is made and sent out and the red tag put in the bin, marked "order placed."

When the new material arrives, separate from the new supply again the new batch, to form a fresh "order point" quantity of minimum supply, and tie it with a red


S

STORES TAG NO. | CHARGE TO ORDER NO.

QUANTITY	UNIT	TOTAL WEIGHT LBS.	UNIT VALUE	TOTAL VALUE

DESCRIPTION

STORES ISSUE

GENERAL STOREKEEPER

MR.

PLEASE ISSUE ABOVE TO

SIGNED BY MAN FOR WHOM STORES ARE ISSUED

MONTH | DAY | YEAR 191

ENTERED IN

STORES TAG	BALANCE ACCT.	P. V.	COST ACCT.

STORES DESCRIBED ABOVE HAVE BEEN ISSUED

SIGNED BY GENERAL STOREKEEPER OR HIS REPRESENTATIVE

Sample of standard form for stores issue slip

tag or seal. Continue to issue stores from the *last* delivery without touching the new shipment until all the old supply is completely used up. This protects against deterioration of small leftovers.

Pricing Stores: When the stores keeper issues stores to sub-stores he returns the copy of the stores issue slip priced "unit value." When articles are placed in sub-stores the prices are transferred onto the bin tags.

Whenever issues are made from the sub-storeroom these prices ("unit value") are transcribed on store issues and properly symbolized.

Once a week the chief engineer or power plant clerk enters the value of materials issued for maintenance and repair on the repair card against the job where used. If materials were used in operation, not for maintenance, their values are summed up at the end of the month and charged to operation under the proper expense symbol.

Distribution Costs: At the end of each month the summation of all charges against each symbol or order number of department is made, and the totals are forwarded to the accounting department.

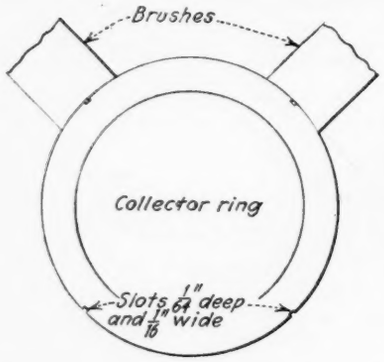
This summary will not include supplies which are drawn from the general store but remain in the sub-store unissued. This end of accounting is handled by the general store. Otherwise the same article may appear in general accounts as issued twice.

Special Stores: When special stores are wanted, the chief engineer prepares a "purchase requisition," attaches to it the full specification, name and address of supplier, etc., and obtains the O.K. of the general superintendent. Then he forwards this purchase requisition to the purchasing agent and, upon securing the material, handles it according to regular practice as described above.

Right Out of the Plant

Reducing the Wear on Slip Rings and Brushes

THE slip rings of alternating-current generators and motors often wear unduly because of abrasive grit, derived partly from the wear on the rings and the brushes and partly from the atmosphere getting between the brushes and the rings. As this grit has no means of



Grooves in face of slip ring collect abrasive grit and prevent it working into the brushes

escape except across the face of the ring, it tends to work into the brushes.

This trouble can largely be prevented by cutting four shallow narrow grooves around the face of the slip ring, as shown in the drawing.

These grooves can be made with a hack saw. They should be about $\frac{1}{64}$ in. deep, the edges being smoothed down to give a good surface. The dirt which is worn from the rings and brushes will collect in these grooves instead of under the brush face.

The adoption of this method has in many cases reduced the wear on the brushes and rings and improved the operation of the unit. W. E. WARNER.

Brentford, England.

Uniflow Engine Vs. Turbine

IN *Power* for Aug. 27 there was a chart showing the attainable power output per thousand pounds of steam from uniflow engines and turbines at varying initial and back pressures. Data compiled from manufacturers' tests and actual performance of installations show that the uniflow when properly designed for non-condensing operation can do better than the chart shows. For instance, at 175 lb. initial, 0 lb. back pressure and 200 deg. superheat, the chart shows a water rate around 15.1 lb. per hp. for the uniflow, while in practice one make of uniflow can consistently show a rate of 13.6 lb. per hp. at 175 lb. and considerably less superheat than 200 deg.

Likewise, at 335 lb. initial and 20 lb. back pressure, the water rate on the chart is 19 lb. per hp., and in a large paper mill at 300 lb. initial pressure a uniflow attained a rate varying between 19 and 21 lb. per kilowatt-hour, corresponding to approximately 14 lb. per indicated horsepower. In the same plant a turbine operating at 300 lb. initial pressure and only 5 lb. back pressure showed 25 lb. per kilowatt-hour, corresponding to 16.9 lb. per horsepower. A mechanical efficiency of 90 per cent is assumed in converting water rates from a kilowatt-hour to horsepower-hour basis. The chart giving a turbine a lower rate expanding from 335 to 20 lb. favors the turbine unduly, as it would have to show a Rankine cycle ratio of 89 per cent, and no ordinary size used in industrial plants has ever shown so high a ratio. In the largest central station the high-pressure turbine stages seldom show over 85 per cent Rankine cycle efficiency, while, on the other hand, uniflow engines even in moderate sizes have exceeded 85 per cent.

Springfield, Mass. A. F. SHEEHAN.

Flow Characteristics of Standard-Type Valves

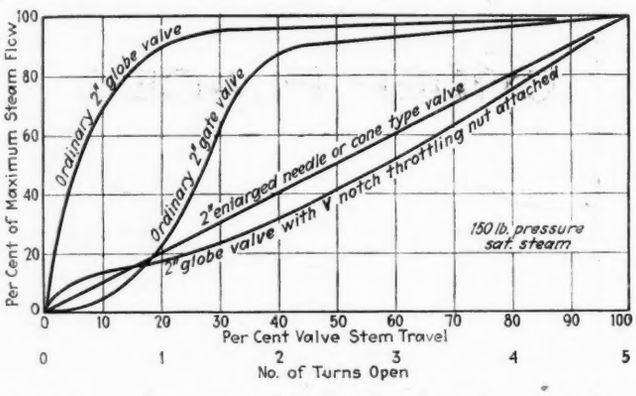
FREQUENTLY in a power or manufacturing plant when it is desired to minutely control the flow of steam or air we hear the expression, "The valve is only *cracked* open."

This expression always conveys the idea that the smallest amount of either of these fluids is passing through the valve that is humanly possible to control.

In the chemical, paper manufacturing, refining, and dye industries huge quantites of live steam and compressed air are introduced directly into the products in one or more phases of the processes for heating and agitating.

The fluids thus used often represent as much as 70 per cent of the entire boiler load, and their monetary value is, of course, absorbed in the cost of the product; hence many executives take the stand that as long as the fluids are measured by meter, some control exists. This is true in many respects. But how many engineers and executives realize that accurate fluid-flow control cannot be accomplished by the ordinary globe or gate valve?

Every engineer who has had to face fluid control problems knows that there is a wide margin of waste


Per Cent of Maximum Steam Flow
100
80
60
40
20
0
Ordinary 2" globe valve
Ordinary 2" gate valve
2" enlarged needle or cone type valve
2" globe valve with V notch throttling nut attached
150 lb. pressure sat. steam
0 10 20 30 40 50 60 70 80 90 100
Per Cent Valve Stem Travel
0 1 2 3 4 5
No. of Turns Open

Curves show venturi-type valve best for control of flow

between the amounts of these valuable fluids actually used in a process and the amounts actually necessary, and any efforts toward economic control are in most every case richly rewarded.

While working on a steam control problem of a metered process consuming 27,000 lb. of steam an hour I had occasion to measure the steam-flow characteristics

through various types of valves, and an astonishing series of results was recorded, as shown in accompanying graph.

Four valves were tested; one a two-inch globe valve, another a two-inch gate valve, the third a two-inch valve resembling an oversized needle valve, the fourth a two-inch valve with a V-notch throttling nut attached to its disk.

It is quite apparent that a wide range of flow control could not be obtained with the ordinary globe or gate valve, as the former passed practically the maximum amount of steam through it with only one turn of the hand wheel, while the latter at two turns open allowed practically the maximum flow to issue through the valve.

The needle, or cone, type of valve showed ideal straight-line flow characteristics with every increment of opening of the hand wheel; hence it is the ideal type to use on fluid-flow control of processes requiring intimate contact of fluids with the product, as it allows a wide range of control.

The V-notch throttling arrangement on the last two-inch valve tested showed results almost identical to the needle type of valve, but gave too much throttling at the half-open position.

It was decided to install the enlarged needle type of valve on the various steam outlets to the process, and the most economical increment of opening was determined and marked to enable the operators to keep within the economic range. The steam consumption of the process was decreased 9,000 lb. per hour, an appreciable saving, with a betterment in the product. The cost of the steam saved every day amounted to $54.

Bayonne, N. J. E. A. Baerer.

Mechanical Stresses Seen as Chief Cause of Cracks in Boiler Plate

IN *Power* for July 23 there appeared a discussion of the effects of mechanical stresses and causticity in producing failures in boiler plate. This discussion is timely in view of the general tendency to higher pressures and temperatures in boiler service.

The effect of pressure in creating stresses at the edge of holes is a fact which, it is believed, has been well demonstrated.

Theoretically, we find that a stress does exist in the plate at the edge of the hole three times the average in the section of a plate when a perfect elastic and isotropic material is assumed. Steel is not a perfect elastic or isotropic material.

The Fatigue of Metals Laboratory at the University of Illinois, using the endurance limit as a measuring stick, has demonstrated that a hole has the effect of increasing the stress at the edge of the hole 1.98 times in steel. By pulling a series of polished specimens we have demonstrated, by using Luders lines as a measure, that the stress is increased 2.01 times in steel. These two methods may be considered to check.

In view of the question of stress intensification in holes and of the fact that mechanical stresses are seen as the chief cause of cracks in boiler plate, it seems that the natural inference drawn in the last paragraph of the paper "that riveted boiler joints must go" has a logical foundation. Especially is this appropriate for the severe service for which boilers are now being used.

Milwaukee, Wis. T. McLean Jasper.

Pointers on Retubing a Surface Condenser

WHEN a new condenser is to be tubed it is best to make a wooden cover just the size and shape of the tube sheet and secure it against one of the tube sheets. One-inch finished boards six inches wide are good for this service. The cover should be small enough to fit inside the water box, but large enough to cover all of the tubes. If the condenser is large it is well to make the cover in halves or even quarters to facilitate erection and to allow part of the tubes to be packed while others are still being put in place.

Condensers have, as a rule, two or more support plates between the two tube sheets, so located that the tubes are about a quarter of an inch higher in the middle than at the ends. This facilitates draining the tubes, keeps sand and other particles from lodging in the low spots, and tends to keep them from vibrating in the support plate.

When tubing the condenser, two men at least are required on the outside to handle and start the tube. On the inside there should be a man at each support plate and at the far tube sheet. The first tube should be started at one corner, so that the workmen on the inside can find the corresponding place in the other plates easily. They should be put in following straight rows and each tube should be pushed all the way through until it hits the board cover at the other end of the condenser.

After the tubes are in place the wooden cover can be removed and the packing put in and the ferrules screwed up. The ferrules should not be screwed up so that the shoulders come tight against the ends of the tubes. Care should also be taken not to tighten the packing too much, or the tube may be crushed when the packing gets wet and swells.

Many types of packing are available; corset lace which comes in long strings, sometimes soaked in paraffin, is probably the most used. The proper length should be determined so that the ferrule will screw in far enough to leave just a little clearance between the tube and the shoulder. If this clearance is too great the tube will gradually work over to where all the clearance is on one side. All the packing should be cut the same length. When the tubes are packed, the steam side of the condenser should be filled with water and the packing allowed to soak several hours before the water boxes are put on. Then the ferrules should be tightened to prevent leakage.

With practically all types of packing, including corset lace, it is well to use thin rings of fiber at the bottom of the packing space and against the ferrule. The corset lace should be wound in clock-wise, and when the ferrule is screwed in it will tend to tighten the packing rather than loosen it.

When putting a few isolated tubes in an old condenser, it is impossible to have a man on the inside. In this case it is well to take a length of small pipe and insert it in the tube before the old one is withdrawn. The pipe will guide the new tube and make it easy to put it in place. The packing and ferrules are put on the same as before, but the ferrule must be drawn up a little tighter, because it is usually not possible to let the packing soak for some hours before putting the condenser back into service. P. F. Rogers.

Brooklyn, N. Y.

Color Should Not Be Made Criterion in Oil Specification

WITH reference to the article in the Aug. 13 number of *Power* by H. L. Kauffman entitled "Color Should Not Be Made Criterion in Oil Specification," I had a more or less interesting experience along this line which may be of interest to other readers.

Our plant consists of several types of prime movers and generators totalling 10,000 kw. A 3,000-kw. turbine unit had been down for general inspection and fresh oil was being put in before the trial run. The turbine engineer and I agreed that the oil was extremely light in color and body and did not meet with our approval.

We sent two samples—one of the former oil and one of the new oil—to the factory chemist, with a request for quick analysis. Meanwhile the unit was turned over for some time at quarter speed. Careful watch was kept on the oil temperatures, but no unusual rise was noticed. However, when the unit was brought up to speed and given some load it was impossible to maintain the usual 60 lb. pressure to operate the governor. About that time the chemist called me on the phone and said, "There's nothing the matter with the new lot of oil—the viscosity is O.K."

After the run we examined the pump strainer and found the trouble, dirty screens from wiping-cloth lint! Color does not mean a thing. C. W. PETERS.

New York City.

Boiler Efficiencies With Natural Gas

ANYONE unfamiliar with natural gas, after reading the article by Haylett O'Neill entitled "Boiler Efficiencies With Natural Gas," in the Aug. 6 issue of *Power* may not understand when the high and the low heating values should be used in designing a power plant or analyzing its performance. When purchasing gas burner equipment it is necessary that the capacity be ample to supply all the fuel required to develop the maximum steam output of the boiler unit. This presupposes the use of the low heat value of the gas, or that value that is established by eliminating the heat developed by its hydrogen content.

On the other hand, in laying out boiler heating and superheater surfaces, as well as the gas passages through them, one must not disregard the fact that the hydrogen content will increase the quantity of combustible gases passing from the furnace through the boiler setting. The same is true in designing a natural-draft stack or induced-draft fan equipment for gas fuel. In other words, one must take into consideration the fact that the hydrogen in the fuel gas goes through the process of combustion and that the resulting gases must pass through the boiler and be emitted through the stack.

Probably one of the reasons that naturally inherent high boiler efficiencies are secured with natural gas fuel is the fact that the gas over long periods is of uniform composition and quality even though the supply may come from several wells in the same field. Operators soon learn to utilize this practically constant fuel at its maximum efficiency by decreasing the excess air to a minimum. However, one should not be deceived if the efficiency figures are high, because they probably have not been corrected for the hydrogen in the fuel. Engineers are not in the habit of correcting efficiency figures for the hydrogen content when coal and fuel oil are used, because it is a small amount. In the case of natural gas, where hydrogen not only occurs in combination with other elements but also occurs free, it represents a larger part of the fuel used.

The A.S.M.E. code is justified in using the high heat value for natural gas, because we do not correct the heating value of other fuels for this constituent. It is largely left to one's own judgment whether or not he should correct efficiencies for the hydrogen content in natural gas for a particular instance at hand. To do so gives a better idea of the true efficiency secured.

New York City. W. S. JOHNSTON.

Separating Oil From Feed Water in an Open Heater

THERE has been considerable discussion in *Power* from time to time on the various methods of removing oil from feed water. It is probably not generally known that most engineers have at their disposal and in their own plants the means of making an effective oil separator. There are few plants nowadays without an open feed-water heater. This type of heater can be used to separate the oil from the water, and, particularly, from the oil that has emulsified.

The method we use is nothing more than putting a substantial bed of coke in the heater. It seems that coke has an affinity for oil and readily absorbs it. This is a simple and cheap remedy, as coke is produced in every furnace using bituminous coal and enough can be picked out of the ash heap to fill the heater.

Of course, with a closed heater conditions are different. In that case an improvised coke oil extractor can be placed in the suction line to the feed pump. Containers for the coke can be made from oil drums or sections of large-diameter pipe.

For a while we used charcoal in our heater as an extracting medium, but after experimenting with coke we found it worked equally well. Furthermore, it is cheaper and more readily obtainable in the majority of plants and can be changed as often as necessary without any expense other than the labor of picking it and putting it in the heater. JOSEPH O'BRIEN.

Rosedale, L. I.

Tri-Sodium Phosphate as a Cleaner for Equipment Parts

CLEANING small pumps, burner tips and other parts of equipment coated with dried or burnt grease or oil always has been a tedious and more or less futile job with us. This year we dismantled our three return pumps on the heating system for inspection and repair, and they were in a very dirty condition. One of the mechanics suggested that we clean the various parts with tri-sodium phosphate, which, although harmless to the skin, has potential cleaning powers with reference to oil or grease.

We used a water-tight barrel with a small steam pipe connected to it for heating. Then all of the parts of one pump were put into the barrel, after which it was two-thirds filled with water and a gallon of tri-sodium phosphate. A little steam was then turned on. After an all-night treatment in this solution the cleaning was complete. When the pump was reassembled it was given a new coat of paint. The three pumps are now cleaned and refinished and ready to be put into service.

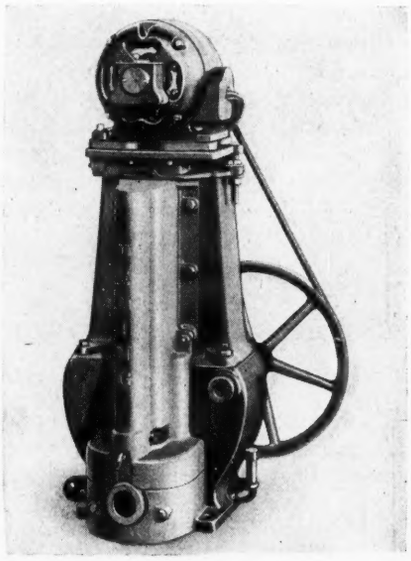
Anderson, Ind. GEORGE S. BILLMAN.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

New Deep-Well Pump Fully Inclosed

IMPROVED forced-feed lubrication, V-belt drive, fully inclosed operating mechanism, simplified air compressor and improved appearance are among the features claimed for the new deep-well "Oil-Rite" pump, manufactured by the Deming Company, Salem, Ohio. A new lubrication system has been incorporated in the new pump, and this has eliminated several moving parts. The air compressor has been simplified, with a consequent reduction in the number of parts. The pump is designed for use where the vertical lift exceeds 35 ft.



Motor-driven deep-well pump

Special Tools Facilitate Cleaning of Oil Purifier Bowl

ORDINARILY, the range of uses to which a centrifugal oil purifier is put does not necessitate the bowl of the machine being cleaned more than once a day or at infrequent intervals. However, in certain uses where a purifier may be run more or less continuously, as in plants equipped with Diesel engines, the bowl may have to be cleaned every few hours.

Although no special tools other than the wrenches, etc., regularly supplied with the machine are necessary to clean the bowl of the Nos. 600 and 900 oil purifier put out by the De Laval Separator Company, 165 Broadway, New York City, certain tools have been made available which facilitate the work and safeguard the parts from injury.

The accessory equipment for the No. 600 machine consists of a welded iron frame shaped to hold all the bowl parts as they are removed from the machine. The frame is hung directly on the purifier after the covers are removed and the work of cleaning is done in the usual way except that the heavy parts of the bowl are not lifted more than a few inches for dismantling or assembling. The top of the bowl is placed across the two lower arms of the hanger while the bowl shell is laid across the two upper arms in a convenient position for cleaning. In this position the bowl is readily turned to suit the convenience of the operator. When not in use the device is hung on the wall.

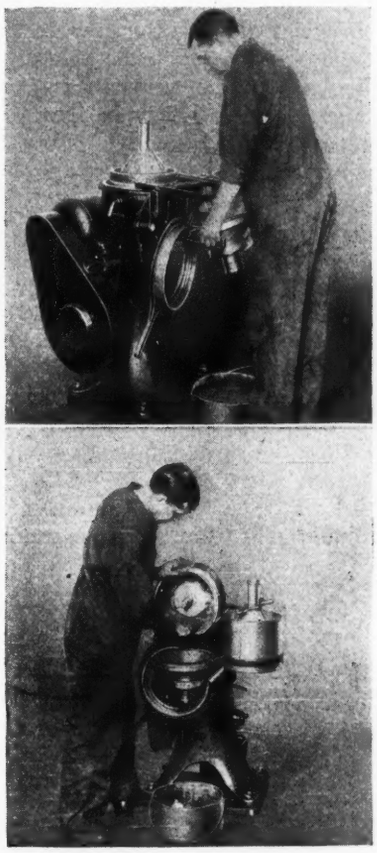


Fig. 1—Welded iron frame to hold bowl and tools used with the No. 600 machine

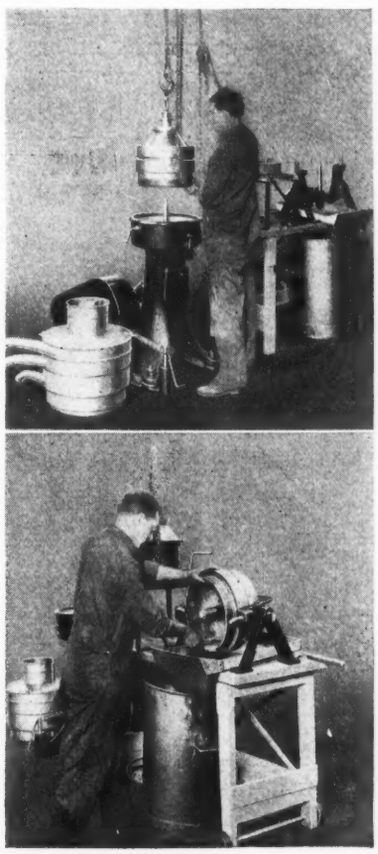


Fig. 2—Tilting bowl vise as used with the Nos. 600 and 900 machines

Fig. 2 shows a tilting bowl vise furnished for the No. 900 purifier. The vise is equipped with a spindle, similar to that in the purifier, on which the bowl is placed for cleaning. The vise is constructed so that the bowl may be tilted or rotated at will. A special ratchet-type lever on the vise is used for loosening and tightening the bowl's coupling ring. A pan holds the disks and another, placed directly under the vise, receives the water and dirt from the bowl and discharges it to a suitable container.

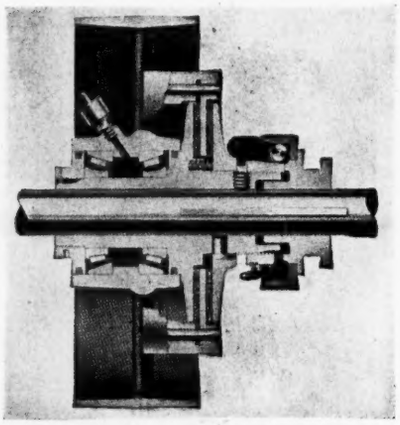
This tilting vise equipment is available for both the Nos. 600 and 900 machines, while the iron frame previously mentioned is furnished only for the No. 600 unit.

Disk Clutch With Asbestos-Metallic Friction Liners

FEATURES of the type SF disk clutch illustrated are oil-sleeve bearings, a choice of tapered roller or transmission ball bearings, extended sleeves for mounting pulleys, sheaves, and gears, or cut-off couplings for connecting and controlling two shafts.

The clutch has renewable asbestos-metallic liners of large friction area, a hardened steel cam and rollers and means for effecting a quick release without dragging. A single operating adjustment consists of pressing down on the locking lever and turning the adjuster until the lever snaps into the next slot.

Improved design and better balance make the clutch suitable for operation at high speeds, and it is claimed by the manufacturer, the Edgemont Machine Company, 2200 Home Ave., Dayton, Ohio, that centrifugal force will not cause the parts to engage the clutch or cause dragging at any speed. The levers push on the plate without sliding action, doing away with wear at that point. Easy operation is assured by the rollers in long levers, and there is no sliding under heavy pressure.



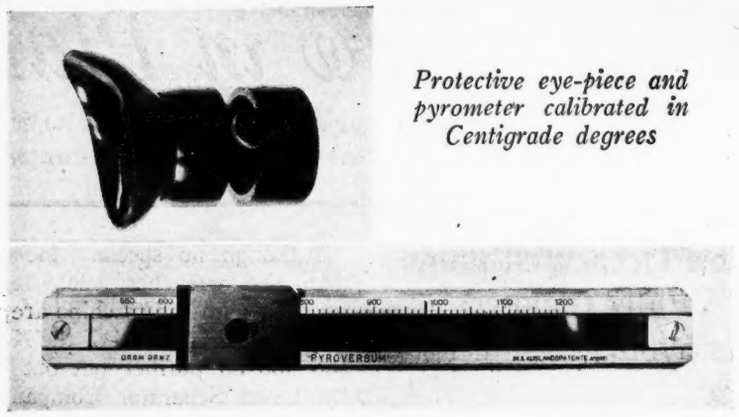
Sectional view of clutch

New Type Optical Pyrometer

PYROVERSUM is the name given to a new type of optical pyrometer by the Mace Template & Engineering Company, Ltd., 19 Cursitor St., London, E.C. 4.

The instrument, which is suitable for reading the temperatures of boiler furnaces and for various uses in metallurgical and similar operations, consists of a frame 8½ in. long x 1 in. wide, which carries a special shaded glass. One end of the glass is clear, being gradually darkened throughout its length until at the other end it is practically opaque. On one side of the frame is a scale 5½ in. long, registering from 550 to 1,200 deg. C., or it may be calibrated for Fahrenheit readings (500 to 2,500 deg). On the frame is mounted a slide having a circular hole in the center through which the hot body may be seen through the shaded glass. At any convenient distance the user, looking at the object through the hole in the slide, moves the frame along until the glow can no longer be seen. The temperature may then be read on the scale at the left-hand side of the slide. The scale is calibrated for every ten degrees.

A protective eye-piece, as shown in the upper view of the illustration, is furnished with the instrument. It fits over the opening in the slide. The pyrometer can be carried about in the pocket as readily as a rule, its weight being half a pound. Representing the firm, Charles Mitchell, Cornish Arms Hotel, 311-323 West 23rd St., New York City, will distribute the instrument in this country.

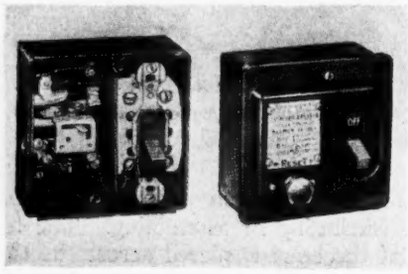


Protective eye-piece and pyrometer calibrated in Centigrade degrees

Overload Breaker for Small Motors

DESIGNED for use with motors driving small machines and auxiliary equipment, such as pumps, compressors, fans, etc., the overload breaker illustrated is being put out in six forms and in capacities up to 1½ hp. at 220 volts.

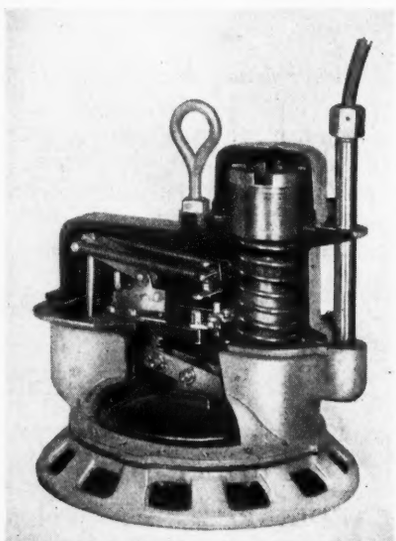
The breaker is suitable for use with direct-current motors and alternating-current single-phase and polyphase motors. It is designed for protection against burnouts and overload. The device, which is put out by the Allen-Bradley Company, 286 Greenfield Ave., Milwaukee, Wis., can be obtained with or without snap switch and fuse clips.



Breaker with cover removed

Submerged Diaphragm Switch for Motor Control

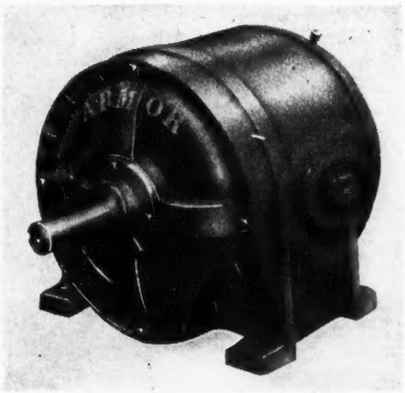
FOR installation in any sump or tank for controlling pumps or indicators, Barrett, Haentjens & Company, Hazleton, Pa., have developed the Hazleton diaphragm switch illustrated. According to the manufacturer, the switch, which is inclosed in a water-tight housing, is portable,



Cut-away view of diaphragm switch

requires no special mounting and is particularly recommended for inaccessible locations or places having insufficient headroom for the conventional float switch with its chain or rod and counterweight. It may be suspended at any depth in the tank or placed on the bottom, and a dip of 20 deg. will not interfere with its operation.

The switch mechanism is of the quick make-and-break type, operated by the pressure of the water on the underside of the rubber diaphragm. Air displaced by the movement of the diaphragm is exhausted through a vent pipe. The housing proper is submerged in the water, and electrical connection is made through rubber-covered cables.



Armor totally enclosed motor

Totally Enclosed Air-Cooled Motor

BUILT in sizes up to 50 hp., the totally enclosed motor illustrated is fitted with heavy cast-iron end brackets designed to increase the radiation of heat by means of heavy ribs which carry the heat from the brackets to the outside rings. The housing is also designed to give maximum protection against the entrance of explosive gases or abrasive substances.

Ventilation of the motor is effected by a substantial fan keyed to the shaft and clamped in place by a nut. Provision is made for taking air gap measurements at four points, and means for removing an accumulation of dirt from the interior without dismantling the motor are also provided. The bearings are of the adjustable anti-friction type.

It is claimed by the manufacturer, the Armor Electric Manufacturing Company, Erie, Pa., that the temperature rise on a continuous full load will not exceed 55 degrees.

Circulator for Hot-Water Heating Systems and Industrial Services

ALTHOUGH developed primarily for increasing the circulation in heating systems, the motor-driven

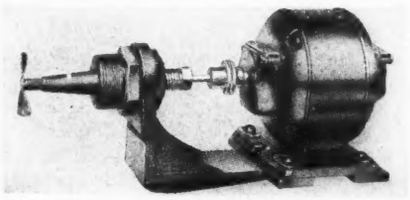


Fig. 1—Circulating unit

circulator illustrated, put out by the Rochester Circulator Sales Division, 429 Ravenswood Ave., Rochester, N. Y., is equally well adapted to a number of uses in the industrial field.

The circulator consists of a propeller direct connected to a motor through a flexible coupling. The complete unit is supported from the bearing block, which is made to screw into a standard pipe fitting, as shown in Fig. 2. The bearing is fitted with a hard-rubber sleeve, and water is used as a lubricant.

The bearing is sealed against leakage by the natural pull of the propeller forcing a bronze collar on the shaft against a stationary hard-rubber washer. This gives a water-tight bearing with little friction. The shaft is made of tobin bronze, and the propeller of manganese bronze. Provision is made for swinging the motor's supporting bracket on the bearing block so that the motor can be placed level when the plug or bearing block has been tightened in the fitting. If necessary the circulator can be dismantled to permit installation in crowded quarters.

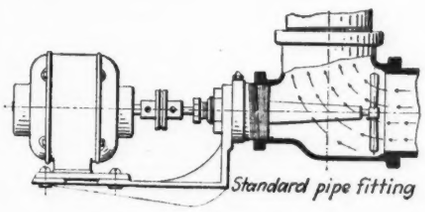
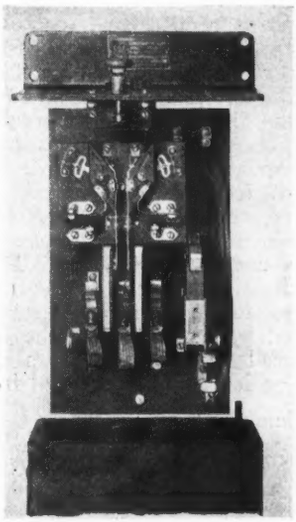


Fig. 2—Circulator in position in pipe line

Among the uses to which the circulator is particularly adapted in the industrial field are the circulating of brine in cooling tanks, cooling water in large air compressor units, water in large capacity service or process water heating systems and other similar services.

It can be used with practically any liquid which can be circulated under low head and which can be carried in standard pipe fittings. For certain fluids the parts in contact with the liquid are made of monel metal, chromium or cadmium plated. Circulators can also be had with special pitches and speeds of the propeller to meet different conditions of velocity and head.

The circulator is available in a wide range of sizes from $1\frac{1}{2}$ to 12 in. Sizes $1\frac{1}{2}$ to 8 in. are screwed for standard pipe fittings, and the 10 and 12 in. sizes are mounted in flanged cover plates.



Switch mechanism raised from tank

Magnetic Switch With Oil-Immersed Contacts

AN OIL-IMMERSED magnetic switch for use in gaseous atmospheres or in locations where highly corrosive gases or acids are encountered is announced by the General Electric Company, Schenectady, N. Y.

The new switch has a capacity of 40 amp. and can be used with any motor from 110 to 600 volts the full-load current of which does not exceed this value. The contactors and interlock are standard in design, and the overload relay has oil-immersed contact tips in which the heaters are located above the oil level. The relay is reset from the top of the tank. The inclosing tank is of $\frac{1}{4}$-in. sheet metal with a flange for wall mounting.

FROM AMONG READERS' PROBLEMS

Conducted by L. H. MORRISON

CAPACITY PERFORMANCE CURVE OF CENTRIFUGAL PUMP—*I have a single-suction 6-in. centrifugal pump driven by a motor at 1,200 r.p.m. Is there any method whereby I could calculate the quantity-head performance curve for this pump?* R. E. B.

The calculation of a pump capacity curve by any of the usual textbook methods is a complicated process. A simplified method, and one that seems to give fairly accurate results, has been worked out by A. F. Sherzer, of the University of Michigan.

This method considers that in a pump there are three points of control, or orifices. The first is at the entrance to the impeller-vane passages, the second is at the discharge from the impeller vanes and the third is at the throat of the pump casing.

The area of these orifices must be obtained by actual measurement of the pump under consideration. Then the velocity through each of these orifices is equal to the volume of water passing divided by the area, and the drop in the head as the water flows through each orifice may be computed from the well-known formula $H = \frac{v^2}{2g}$

The method of procedure is to assume a flow of water through the pump, calculate the velocity and pressure drop through each orifice, and the sum of these three pressure drops is the total loss in head through the pump. If this loss in head through the pump is subtracted from the head at shut-off a point on the performance curve is obtained.

The head at shut-off may be obtained by tests or can be calculated from the equation $\frac{U^2}{2g}$, in which U is the peripheral velocity of the impeller.

By assuming a number of different flows through the pump enough points can be obtained to build up the pump performance curve.

DISCHARGE OF STEAM JETS—*We are using a steam-jet vacuum pump to remove the air from a single-pass condenser. The pump has three $\frac{3}{8}$-in. diameter nozzles and is supplied with steam at 150 lb. How much steam per hour will this pump use?* D. M. P.

The steam used by the vacuum pump would be given aproximately by Napier's rule for flow of steam through orifices when the final absolute pressure is less than 58 per cent of the initial absolute pressure, namely, flow in pounds per second = absolute initial pressure × area of orifice in square inches ÷ 70.

Having three nozzles each $\frac{3}{8}$ in. in diameter, the total area would be $\frac{3}{8} \times \frac{3}{8} \times 0.7854 \times 3 = 0.3312$ sq.in. From the formula, the discharge would amount to $165 \times 0.3312 \div 70 = 0.781$ lb. per second, and the flow per hour would be $0.781 \times 60 \times 60 = 2{,}810$ pounds.

Napier's formula is very simple and easy to use, but should be confined to cases where only a rough check is desired. For closer work Grashof's formula, flow in pounds per second $= 0.0165 \times F \times p^{0.97}$, gives better results, but is complicated by the fractional power of p. Substituting the data of the above question in this equation, we have $0.0165 \times 0.3312 \times 165^{0.97} = 0.769$ lb. per second, or $0.769 \times 3{,}600 = 2{,}765$ lb. per hour.

HORSEPOWER FROM A SINGLE-ECCENTRIC ENGINE.—*What horsepower can I expect a single-eccentric 24 x 48-in. stroke corliss engine to develop when supplied with steam at 120-lb. pressure, operating at 90 r.p.m. and exhausting at atmosphere?* C.H.W.

The horsepower developed by a steam engine may be calculated from the familiar equation: $\text{hp} = \frac{P\,L\,A\,N}{33{,}000}$ where P is mean effective pressure, L length of stroke in feet, A area of piston and N number of strokes per minute. All of the factors in this equation are known except the mean effective pressure, which is usually obtained from an indicator diagram. Since, however, an indicator diagram is, in this case, unavailable, a value for P must be estimated.

The mean effective pressure acting upon the piston depends mostly upon the point of cut-off. If the point of cut-off is known, the mean effective pressure per pound of initial pressure can be calculated by dividing one plus the hyperbolic logarithm of the expansion ratio by that ratio.

With a single-eccentric corliss engine it generally is not possible to secure cut-off later than about $\frac{3}{8}$ stroke, which gives a ratio of expansion of 2.66. Assuming cut-off to be at this point we have $\frac{1 + .9783}{2.66} \times 135 = 100$ lb., which is the mean effective pressure that would be obtained, if the engine were exhausting against zero absolute back pressure, and if the valve setting were such as to give a perfect indicator diagram. It is probably possible to set the valves so that the indicator diagram will approach within 90 per cent of the ideal, in which case the mean effective pressure with the engine exhausting to the atmosphere becomes $(100 \times .90) - 15 = 75$ lb. Using this value for P in the horsepower formula we have $\frac{75 \times 4 \times 491 \times 90 \times 2}{33{,}000} = 802$ hp. This value is, of course, the indicated horsepower. To obtain delivered, or brake, horsepower the mechanical efficiency of the engine must be considered, which, if assumed to be 90 per cent, gives $802 \times .90 = 720$ hp.

This method neglects such factors as the effect of clearance volume on the calculated mean effective pressure, and the difference between the work done in the head and crank ends due to the presence of the piston rod. The result, however, is a fairly close estimate of the horsepower the engine would develop.

HARDNESS TEST FOR STEEL.—*What test can I employ to determine the hardness of steel?* G. W. P.

Hardness of a material is usually understood as a relative property, having reference to the ability of one material to cut another. It is a composite property depending partly upon density and partly on sheer strength.

Probably the best test for hardness as resistance to distortion is that established in 1900 by J. A. Brinell, a Swedish engineer. A hardened steel ball, 10 mm. in diameter (0.393 in.) is forced under a load of 3,000 kg. (6,614 lb.) into the flat surface of the material to be tested. The ball makes a slight indentation, the depth of which is determined with a surface micrometer. Hardness as determined by this test is the load divided by the area of the indentation, which is equal to $2\pi\,rd$, where r is the radius of the ball and d the depth of the indentation.

These data have been found so intimately connected with the tensile strength of the material that it also can be computed with close accuracy. This close connection is evident when it is considered that to displace the material and make the permanent impression the material must have been stressed beyond the yield point. The Brinell test thus gains importance, for it becomes a field test of the strength of the steel which can be applied at any time without appreciable injury or without taking the material out of its place in a structure.

There are several other ways of determining the hardness of steel, such as the electromagnetic and rebound methods.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

IS IT advisable to install centralized temperature control in a hotel or office building? G. R. P.

CENTRALIZED temperature control applied to heating systems in large buildings is not advisable. While possible, it is usually unsatisfactory and uneconomical. The selection of the location for the central thermostat must be such that heat will be available in all parts of the building under all weather conditions. It is therefore necessary to select that part of the building which is most difficult to heat and thus insure the comfort of all the occupants. This results in large heat losses, since the more easily heated portions of the building will be overheated and the usual remedy in such cases is the opening of windows by the occupants rather than the turning off of radiators.

A modified system of control, whereby the heating system is divided into a number of branch systems, each branch serving such a portion of adjacent rooms or offices as is subject to like exposures and radiation losses to the outside atmosphere, with a thermostatically controlled valve on each branch line, is satisfactory. In this case, the uniformity of the heating load served by each branch permits of a centrally located thermostat to serve that particular group. Thus we have, in effect, a collection of small, individually controlled units making up the whole. A master thermostat could be located out of doors which would serve to put the burners in operation at any predetermined outside temperature.

K. E. De Rosay,
Atlantic Refining Company.
Philadelphia, Pa.

IN A HOTEL or office building centralized heating control will become less satisfactory as the size of the building increases.

Even with perfect distribution and proportioning of heating radiation, the outside conditions of weather, such as wind, snow and sunshine, will vary so greatly as to upset the best design intentions.

In addition to this the individual requirements at different points and times will vary so widely that no central control can be really satisfactory, especially when such factors as chimney action within the building and varying total demands are added to the problem.

Zone control from a central point, with careful considerations of the demands and operating characteristics under varying conditions of climate, will, of course, give much better results than a straight simple central control. This type of control will be more satisfactory and economical than that of being sure that the coldest spot is warm enough with the rest of the building wasting heat by "open window control."

R. S. Lane,
Interborough Rapid Transit Co.
New York City.

THE term "centralized temperature control" I understand to mean the operation of a heating system from a central station in the building by means of remote control apparatus.

The two main reasons for the installation of a system of this type are primarily the economy expected to be effected through its operation and the better service expected to be rendered the tenants. Obviously, if both these conditions are fulfilled, the answer to the question would be in the affirmative.

However, there are various factors in each particular instance that influence the actual accomplishment of the expected results. These factors, with a brief résumé, are as follows:

If the steam is purchased or generated primarily for heating, the margin for saving is considerably greater than in a system that uses exhaust steam from a generating plant. In the former both advantages are realized, while in the latter the service feature is the prime factor.

The time during which the premises must be maintained at a temperature of 70 deg. may be the full 24 hr. in hotels, while in office buildings it will vary from 8 to 12 hr. out of the 24. Due to this time element, the net economy of the system would be greater, therefore, in hotels than in office buildings. The office building could figure on some economy, however, in the early morning, when the heating load is at its peak and when each zone could be individually controlled without overheating any one or more zones to bring others up to the correct temperature. This advantage would accrue as well in exhaust steam plants using live steam for this work as in plants generating low-pressure steam for heating.

The pipe system should be properly divided into sufficient zones to get the best results. In a large building of individual floor areas in excess of 18,000 sq.ft. gross and of more than twelve stories in height the zoning should be in both horizontal and vertical planes. These zones should be laid out with some foresight toward prevailing weather conditions during the heating season, notably wind direction and velocity, as well as temperature. In a building in the planning stage the zones can be properly laid out to procure the full benefits of the system. In a building already erected the cost of the changes necessary to get these benefits may overbalance the benefits themselves.

And, finally, the one factor which can influence and overbalance all others is the expense, not only of installation but also of maintenance.

When all these factors are given due weight the decision becomes almost self-evident for the particular installation.

Ideally, the heating system to be operated under centralized control should be divided into sufficient and logically planned zones, arranged and selected in view of prevailing weather conditions. As a necessary adjunct to this system there should be installed some means of having the temperature of the "key room" in each zone readily accessible at the control board. There are several devices on the market that accomplish this remote measuring of room temperatures electrically.

J. W. Degen,
Equitable Office Building Corp.
New York City.

IN HOTELS and office buildings it is advisable to provide for temperature control of each room separately. This is necessary for best efficiency from the fuel as well as for the comfort of the occupants of the building.

Occupants of some of the rooms may require a temperature of 72 deg. or higher. Others may prefer a temperature not exceeding 66 deg. The nature of the work conducted in some of the rooms or offices may require a rapid change of air, with the necessary warming of the incoming air, such as a busy physician's office, where quite a number of people in poor health may pass through in a short time.

From a fuel-efficiency viewpoint, without temperature control in each room there is considerable waste. Frequently when a room becomes too warm—probably only slightly too warm—windows are opened wide and the landlord's fuel heats the outside.

Thermostats can often be used in each room advantageously, and in many cases they will prove a profitable investment through the saving in fuel and the satisfaction to the tenants, thereby cutting down turnover in office buildings and very probably increasing the number of guests per year in hotels.

Robert P. O'Bannon.
Louisville, Ky.

A Question For Our Readers

TO WHAT extent is it economical to allow the temperature of an office building to drop during a winter night? R. P. B.

Suitable answers (of 200 words or less) from readers will be paid for and published in the Oct. 22 issue.

Power Engineers Meet at Chattanooga

Association shows net gain of 1,054 members. Educational work given $10,000 appropriation under protest. "National Engineer" to be published at Philadelphia. Cleveland is the next convention city

IN NEAR proximity to many of the battlefields of the Civil War and mountainous scenery of rare beauty the National Association of Power Engineers held its forty-seventh annual convention at Chattanooga, Tenn. Headquarters for the five-day meeting, lasting from Sept. 9 to 13, inclusive, were at the Hotel Patten. The mechanical exhibition and the business sessions of the convention were held in the Memorial Auditorium, one of the finest structures of its kind in the United States.

Although the general attendance and the number of exhibits did not approach records of former years, the convention was a decided success. Business was conducted with dispatch. Engineering papers added to the value of the sessions, and there was much of interest in an inspection trip showing how boilers are made and in visits to the various battlefields near the city.

The announcement of a gain in membership for the first time in five years was received with enthusiasm. The work of a newly appointed promotion committee has resulted in a net gain of 1,054 members, the total enrollment now being 20,285 as compared to 19,231 a year ago. Thirty-seven associations showed increases in membership ranging from 10 to 432, giving the largest number of flag winners in the history of the organization. Pennslyvania No. 1, of Philadelphia, led in the contest, with a gain of 432. Five new associations have been added, one reinstated, the charters of three returned, nine associations suspended and five consolidated into two.

An interesting bit of news was the awarding of the five-year printing contract for the official organ, the *National Engineer,* to Williams & Company of Philadelphia, beginning February, 1930.

Delegates to the convention numbered 316. In the mechanical exposition 118 exhibitors displayed their products in 147 booths. Resulting profits permitted the presentation of a $3,000 check to the association, with the promise of a few hundred dollars more that may be available. The treasurer's report showed a cash balance on hand July 31, 1929, of $20,318.75. Income from the *National Engineer* amounted to $20,007.07.

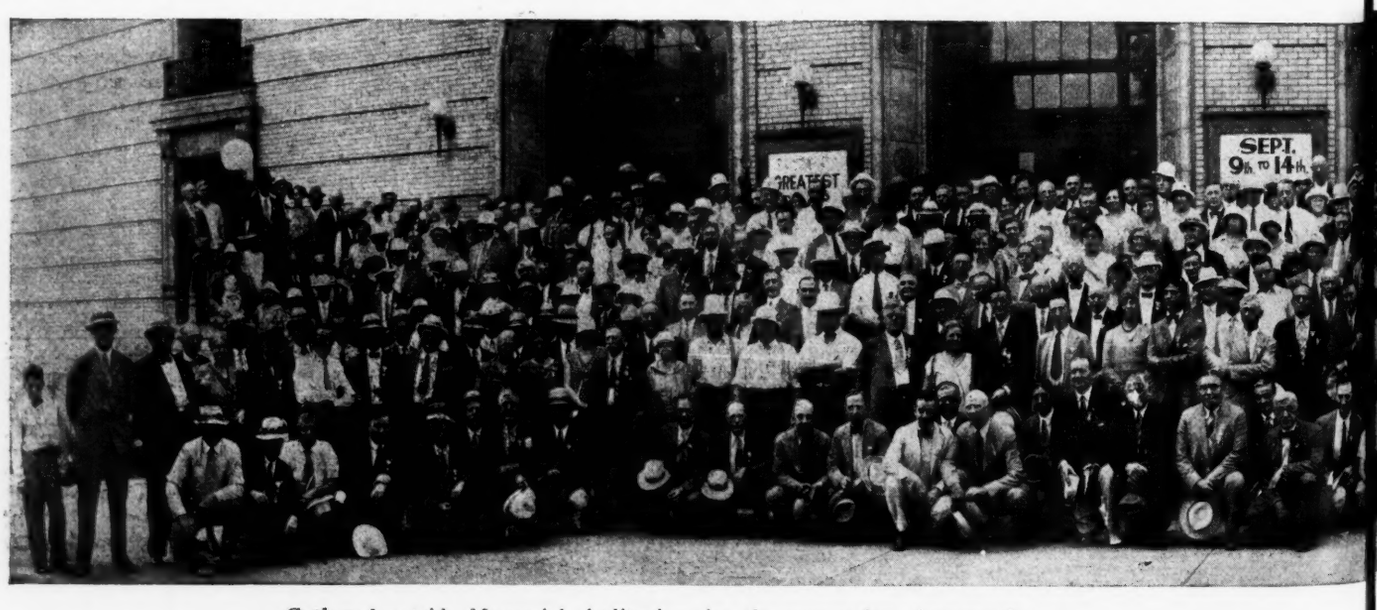
Estimated income for the new year was placed at $67,700, and total expenses, including appropriations, at $53,456. Among the appropriations $10,000 was awarded to the educational committee and $3,000 to the promotion committee.

Owing to a need for economy and the fact that there were only six hundred active participants in the merit courses, the original appropriation for education had been reduced to $5,000, just half the amount that had been devoted to this purpose in previous years. It was argued that the cost of the service was too much for the number participating and worked a hardship on the balance of the organization. Good business procedure did not warrant the expenditure of $7,500 for salaries and office expenses to administer the $2,500 balance. The proposed reduction incited a spirited controversy. Adherents of the educational plan came to its rescue. They pointed out that only about one-third of the appropriation was spent on the merit system, the balance being devoted to power plant cost accounting and information service, which were available and of value to all. According to the numbers involved, the appropriations suggested would mean less than $10 per man for education and over $50 for mileage. A plan was advanced whereby raising the price of the courses and publishing the cost-accounting data at a reasonable price would reduce the expense to the association and eventually make this work self-supporting. The educational plan of the organization had been a big factor in the gain in membership during the past year, and as it was the one asset that appealed to the young engineer its adherents did not propose to have the work handicapped.

Education Must Pay

Their arguments won out, and by a two-to-one vote the educational appropriation was made $10,000, with a general understanding, however, that unless definite results toward a paying basis were shown during the coming year a reorganization of the entire educational plan would be in order.

During the convention two papers of engineering interest were presented, one prepared by J. B. Crane and read by A. C. Weigel, of the Combustion Engineering Corporation, sketching modern developments in steam engineering, and the other on engineering education and the power age by Prof. W. R. Woolrich, of the University of Tennessee. With the apprentice system eliminated, three definite methods for training leaders in industry had been developed. One was intensive trade school training, such as



Gathered outside Memorial Auditorium for the convention photograph

is given in Germany; co-operative engineering courses at many of the universities; and adult training of men already at work, such as had been conducted by the university in co-operation with association engineers in Tennessee.

Entertainment consisted of an informal reception and dance at the Hotel Patten on the first evening of the meeting, the annual show by the exhibitors, an inspection trip to the Hedges-Walsh-Weidner boiler manufacturing plants of Combustion Engineering Corp., an afternoon inspecting the scenic and historical attractions, organ recitals in the exhibit hall and music contributed daily by the Standard Oil band of New Orleans, and on Friday evening the grand ball, preceded by public installation of the officers.

Presidential Address

In his presidential address Thomas R. Herlihy dealt broadly with the many problems confronting the association. With a view to increasing the membership and renewing enthusiasm in the various associations, he had conceived the idea of creating the national promotion committee, whose work had been so effective during the latter half of the year. His recommendation was to continue this committee and provide the necessary funds to carry on the work. Consolidation of all the activities of the association in some central office was suggested, this including the offices of the editor, national secretary, educational secretary, information bureau and the promotion committee. Other suggestions were: The holding of weekly meetings by all associations; the reduction of the per capita tax from $1.20 to $1, with a national initiation fee of $1 imposed on new members; the abandonment of power shows at state conventions; exercising of the referendum every two years only; elimination of the word "strike" from the preamble; an aggressive campaign for securing license legislation; and the development of the information service bureau, particularly for those members who have not the time to take up an educational course. All of these recommendations except the change in the tax were approved and adopted by the convention.

McDevitt Praises Deputies

National Vice-President James A. McDevitt spoke of the work of the state and special deputies and for the first time in the history of the organization had arranged for the attendance of a large number of these deputies to relate their experiences before the convention. References were made to the work of the promotion committee, the change in the preamble, attendance at meetings, the attainment of state license laws, and better support for the merit system and for the *National Engineer*.

Summarizing the work of the national educational committee during the year, L. A. Pierson stated that courses on electric elevators and power plant costs had been added to the merit book, complete revision of the original data sheets had been made and 22 pages of data added to the merit book. An increased amount of educational material had been sent out to local educational chairmen; license information had been collected, the first section of a power plant costs manual, of which there were to be three sections, had been prepared; bulletins on powdered-coal driers and pulverizers, power factor and other subjects had been written and widely distributed; the committee had exhibited at the New York and Chicago power shows and at three state conventions.

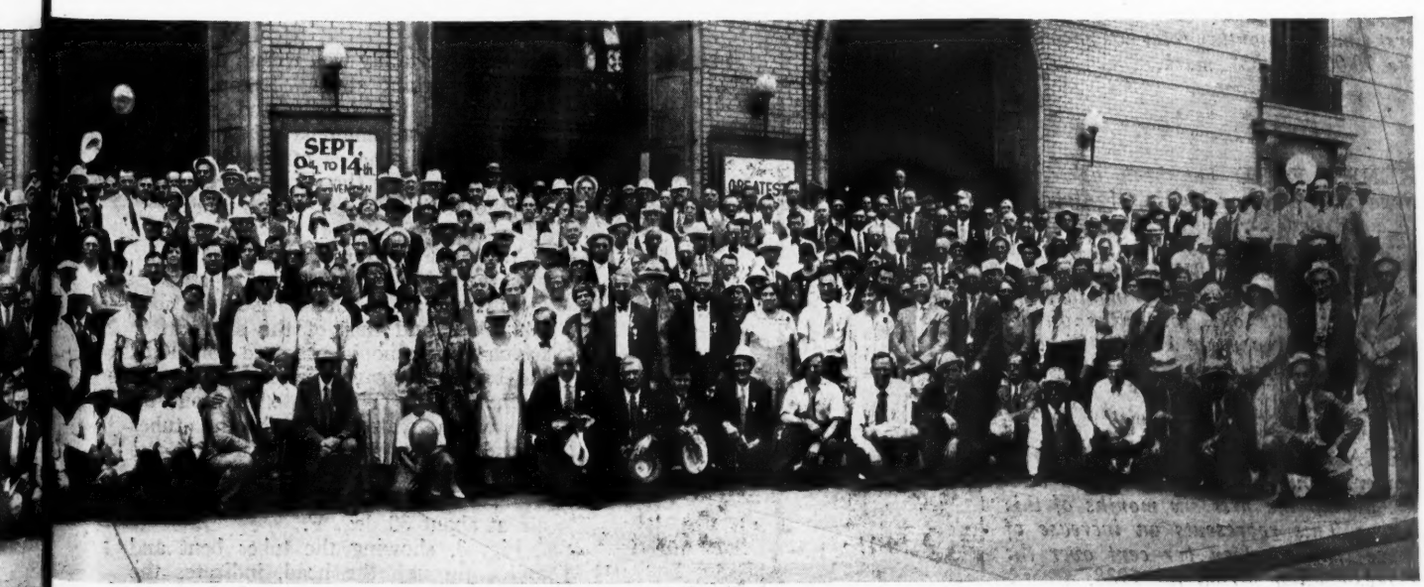
With 1,800 books sold, the committee had reached that 10 per cent of the membership for whom the merit system had any immediate value. Out of a total enrollment of 1,800, approximately 600 men were active, a far higher percentage than for any other correspondence course. Information and power plant cost services were offered to those with no interest in the merit system.

Recommendations for an improved program this year were that the merit system as a unit be made self-supporting by increasing the prices for the work and for each course section graded; that a complete revision of the four-year-old merit book be made at once; that the department, be permitted to go ahead with the preparation of material similar to the power plant costs manual and the question and answer book, deriving a fair profit therefrom; that the secretary be permitted to employ an assistant; that the department be placed in a centralized headquarters; that the national president appoint a license law committee consisting of a representative from each state to co-operate with the educational committee in drafting a uniform license law; that sections of the operation code be prepared and published at a nominal cost; and that a national advisory council for the educational department be created and members to the council be elected by each of the several states, so they can be of assistance in advising as to the work needed and the results obtained in their respective states. An appropriation of $10,000 was requested to carry on the work for the year. This was granted, as were the majority of the requests made, except that for an assistant.

Officers Chosen

Incoming officers of the National Exhibitors Association for the ensuring year are: I. E. Pieters, president; W. H. Gaylord, vice-president; Fred G. Jolley, treasurer; F. N. Chapman, secretary; John H. Allen, John W. Troescher, W. B. Wilson, C. J. Burrage and E. H. Smith, executive committee.

Cleveland was chosen as the next convention city. Officers elected for the N.A.P.E. were: President, James A. McDevitt, of Philadelphia; vice-president, C. A. Dobson, of Knoxville, Tenn.; secretary, Fred W. Raven, of Chicago (re-elected); treasurer, S. B. Forse, of Pittsburgh, Pa. (re-elected); conductor, George T. Smith, of Chattanooga; doorkeeper, A. F. Ford, of Boston; and H. A. Crego, St. Paul, trustees.



N.A.P.E. members appear to be enjoying their stay in Chattanooga

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Spot * News

CONSTRUCTION WORK *has started on the Devils River steam-generating plant of the Central Power & Light Company near Del Rio, Texas. The station will consist of two 7,500-kw. turbine-generators and three boilers. Its ultimate capacity will be 50,000 kw., according to present plans.*

* * *

AUGUST SALES *of mechanical stokers, as reported to the Department of Commerce by the ten leading manufacturers in the industry, totaled 199, of 54,929 hp., as compared with 186, of 65,197 hp., in July and 162, of 51,572 hp., in August, 1928.*

* * *

A DEERFIELD RIVER PLANT *of the New England Power Association's hydro-electric system is supplying water to the town of Shelburne Falls, Mass., as an emergency measure during the protracted drought. The water is being pumped from the penstocks of No. 4 station into the town's mains through temporary pipes.*

* * *

ACCORDING TO REPORTS *received by the Bureau of Mines, the production of crude petroleum in the United States during July, 1929, amounted to 91,327,000 bbl., a daily average of 2,946,000 bbl. This was the first time the monthly total has exceeded the 90,000,000-bbl. mark.*

* * *

HENRY FORD *has been asked by Senator J. Thomas Heflin, of Alabama, to enter new negotiations for the construction of a fertilizer plant at Muscle Shoals. Although Wilson Dam has been completed for many months, the Senator points out, four-fifths of the plant's capacity is not being utilized.*

* * *

TOTAL SALES *of large industrial power amounted to 21,898,000,000 kw.-hr. during the first six months of this year. This represents an increase of more than fourteen per cent over the corresponding period for 1928, according to the N.E.L.A. statistical research department.*

Dairy Brine Cooler Explodes, Killing Three Men

Welded Shell and Tubes Torn Asunder as Workmen Trying to Locate Ammonia Leak Force Warm Water Through Pipes; Property Damage to Houston Creamery Considerable

By Haylett O'Neill

THREE men were killed from ammonia fumes and considerable damage was done to the refrigeration plant when a high-pressure shell-and-tube brine cooler exploded on Aug. 12 at the Phenix Creamery in Houston, Texas. The disaster occurred in the forenoon while workmen were attempting to discover an ammonia leak. The cooler burst when they forced warm water from a hose through one of the tube passages.

The shell was completely blown apart from the cooler body for several feet down into a pit. It was removed after being cut into three parts. The tube section was blown off the foundation, and, in addition, much of the cork-insulated walling of the room was demolished. After the explosion, one man was found holding a nozzle from which fairly warm water was running.

The cooler was a six-pass shell-and-tube type, having 36 tubes, each approximately 9 ft. long. These tubes were expanded into the headers with the ends beaded. The shell was a single-rolled plate about 20 in. in diameter x $\frac{3}{8}$ in. thick, welded autogenously to the heads and longitudinally, as illustrated in Fig. 1.

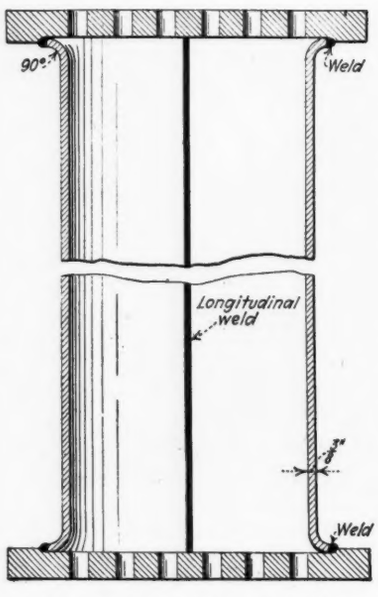


Fig. 1—Longitudinal Section

Fig. 3 shows the tube section and Fig. 2 the cut-up shell after removal to the yard. The line where the left end of the shell was welded to the head, and the ripping of the shell along the longitudinal weld is clearly shown. The tubes originally were straight, but most of them on one of the water passes are bowed outward, and some of them have been pushed through the tube sheet, indicating unusual expansion and compression strains.

Opinion has been expressed that the accident was the direct result of ammonia pressure on the shell due to running warm water through the tubes while the ammonia inlet and outlet were closed, thus raising the pressure of ammonia to the bursting point. It appears there were no safety valves attached directly to the ammonia section.

The writer believes this is only part of the answer. Assuming the water temperature to be about 120 deg. F., which is about as hot as would be handled through a hose, the maximum pressure of anhydrous ammonia would only be about 275 lb. gage, which certainly would not be sufficient to burst the shell. The tension of the shell under this condition would be

$$\frac{20 \text{ in. dia.} \times 275}{2 \times .375} = 7333 \text{ lb. per sq.in.}$$

This is certainly well within the limits of steel working stress. It can also be shown that the tensile and shearing stresses of the ammonia pressure tending to pull the heads off would not be sufficient to cause the rupture even without the holding power of the tubes.

In the opinion of the writer, the failure occured from two actions. There was the initial rupture due to stresses from temperature differences of the head and tubes and that of the shell, after which the ammonia pressure completed the break by tearing along the longitudinal weld. That is to say, putting the warm water through the tubes tended to expand them, while, at the same time, the shell was contracted by being surrounded by the cooling room air at about 30 deg. F.

Fig. 3, showing the tubes bent and pulled through the head, indicates the extreme strain tending to push the heads away from the shell ends. A close

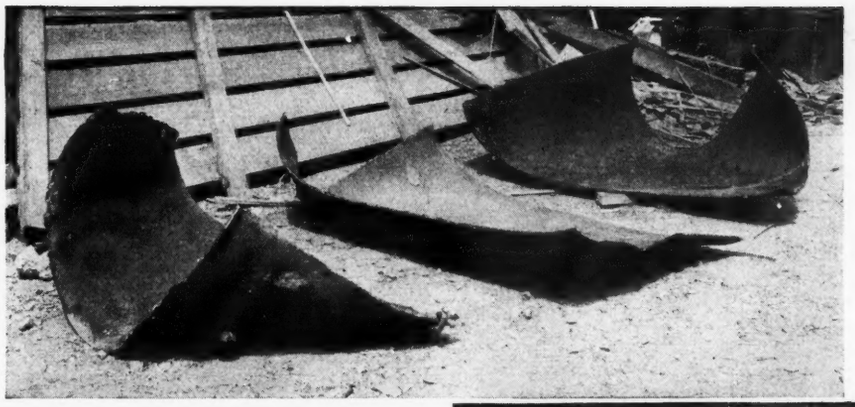


Fig. 2—Cut-up shell after removal from cooler room where explosion occurred. Note welded seams

Fig. 3—Tube section, showing pipes bent and torn through head due to severe strain

examination of Fig. 2 indicated that the fillet on one of the ends of the shell is almost a 90-deg. bend, which apparently was the original construction, while that on the other end is pulled open to nearly 135 deg., indicating a terrific stress caused by tube expansion. There would also be the shearing stress at the welded joint due to the heating up of the head while the shell remained at approximately 30 deg. F. With these three forces concentrated at the junction of the circular and longitudinal weld, it is easy to see how the initial failure could result.

Certain conclusions may be drawn from this explosion. First, in welded vessels it would be well to locate the junction of the circular and longitudinal end weld, which is the weakest point, near the last water pass, at which point there generally would be less temperature difference between the tubes and shell in case hot water were used. Second, double safety valves on ammonia compartments should be installed and tested regularly for leaks and freedom of action. Third, in washing out the cooler nothing should be done which would tend to distort the vessel by unequal temperatures at various parts. It would seem advisable to design tubes with some bend so they can have freedom of expansion without distorting other parts of the vessel.

Japanese Railway to Build Power Plant

A modern power plant which will supply power for the electrification of a section of the Imperial Japanese Government Railway is the forerunner of a large number of new and thoroughly up-to-date steam stations to be built in that country in the near future.

Four of the boilers for this station were manufactured by the Babcock & Wilcox Co., Ltd., in England and will be equipped with Fuller Lehigh pulverized coal burning equipment. The remaining four boilers, to be designed and built in Japan, will be fired with forced draft chain-grate stokers of Japanese design.

Complete automatic combustion control equipment for the eight boilers has been ordered from the Bailey Meter Company of Cleveland, Ohio and will be installed in the new Tsurmi Station.

Third National Fuels Meeting Program Announced

ANNOUNCEMENT has recently been made of the complete program for the Third National Fuels Meeting to be held in Philadelphia, Pa., October 7 to 10. All business sessions will take place at the Bellevue-Stratford Hotel, which will be the headquarters for the meeting. Papers to be presented are classified under five main heads: general, power plant, industrial, domestic and smoke abatement. The first four will be considered simultaneously on Monday, Tuesday and Wednesday; while Thursday is to be entirely devoted to the fifth. Closely allied with the technical program are the inspection trips to many of the interesting plants in and near the city.

Secretary of Labor, James J. Davis, is to be the principal speaker at the banquet on Tuesday evening, which will be the high spot in the entertainment program. Other features will include a men's smoker on Monday evening with a theater party for the ladies, a trip to Valley Forge on Wednesday afternoon, and the possibility of witnessing a World Series' baseball game.

Prof. R. H. Fernald will open the meeting on Monday morning, October 7, with an address on "The Fuel Engineer, His Training and Work." This will be followed in the afternoon by general and domestic sessions, held simultaneously. At the general session, Martin Frisch will present a paper on "Economics of Pulverized Coal, Gas and Oil Fuels."

On Tuesday morning there will be general, industrial and power plant sessions. The last named will be devoted to a symposium on recent developments in mechanical stoker design, presented by H. D. Savage, president of the Stoker Manufacturers' Association, and R. A. Foresman, J. G. Worker and J. W. Armour.

At the power plant session on Wednesday morning, three papers on boilers and furnaces will be presented, as follows: "Some Economic Considerations of Water-Wall Installations," by Ollison Craig; "Economics and Design of Water-Cooled Furnaces," by J. S. Bennett and P. N. Oberholtzer; "Effect of Fouling in Boiler Efficiency," by J. W. Pierson.

Thursday will be given over to a consideration of general and specific data on smoke abatement. Dr. Harvey N. Davis, president of Stevens Institute of Technology, will present the results of his investigations, and a symposium on methods of recording smoke density will be given by A. S. Langsdorf, H. V. Breisky and V. J. Azbe. Individual problems of Salt Lake City, Utah, Nashville and Knoxville, Tenn., will also be discussed by J. Billeter, G. C. Fisher and F. L. Wilkinson, Jr., respectively.

Many Steam Plants Being Remodeled

Two new 10,000-sq.ft. Heine "V" type boilers with water cooled walls are being installed at the International Falls plant of the Minneapolis and Ontario Paper Company, Minneapolis, Minn. These are new boilers for replacing the old stoker-fired boilers in the present plant. They are now erected ready for brick-work. Four Strong-Scott unit pulverizers with vortex burners will be used to fire the boilers.

The Procter & Gamble Company at Cincinnati, has been doing extensive revamping of its steam plant at Ivorydale, Ohio. It was recently equipped with Taylor underfeed multiple-retort stokers.

At Wellsville, N. Y., the Sinclair Refining Company is installing two new 750-kw. units, manufactured by the Moore Steam Turbine Corporation. Steam pressure will be 400 lb. gage and 200 deg. superheat. Back pressure on the turbines will be 125 lb. gage.

The municipal plant at Watertown, S. D., is being materially enlarged and a new 1,875-kva. engine-driven generator unit is being installed. This municipal plant also furnishes steam to an underground heating system, heating a large portion of the business district. The plant, which fill be completed about the first of next year, was designed by Charles Foster, of Duluth, Minn.

At the Cahokia station of the Union Electric Light & Power Company, St. Louis, Mo., four unit pulverizers, made by the Riley Stoker Corporation, each having a capacity of 15,000 of coal per hour, are being installed. Two of each of these machines will be installed in two 18,010-sq.ft. Babcock and Wilcox boilers. There will also be installed at this plant a new burner which has recently been developed at this station.

The Pittsburgh Steel Company is building a high pressure boiler plant, 400 lb. per sq.in., in which all of the feed water will be softened in a Cochrane hot-process softener, using trisodium phosphate.

Additional Large Diesels to Be Installed

A 2,250-hp. Nordberg Diesel engine has just been ordered by the Phelps Dodge Corporation. This engine is to go to its plant at Warren, Ariz. where they already have two of the same size and also two 1,250-hp. Diesel engines. This will give them a total installed capacity of 9,250 hp. making it one of the largest plants in the country.

The City of Lubbock, Texas, has also purchased a 1,250-hp. Nordberg Diesel engine. The City of Lubbock now has nine Diesel engines in service, all of them being what are considered small engines. They are now planning to abandon their old plant and build a modern one in which will be installed larger units than they are now using. This 1,250-hp. engine is the initial installation in the new plant.

News of Canada

October Conference to Settle Water Power Rights—Construction Progressing on Beauharnois Project—West Kootenay Operations

OCTOBER is the time set for the conference between the dominion government and representatives of Ontario and Quebec in respect to water power sites. The relative rights of the dominion and the provinces over water power sites on navigable rivers, with the dominion having unquestionable authority over navigation, have never been clearly defined.

A year ago, by means of a reference of a group of specific questions, the Supreme Court of Canada was appealed to, but its findings were few. The court said it could pronounce on a concrete case, but the abstract principle was too involved for a specific declaration. It is thought that, on the principle of give and take, a conference can agree on points heretofore in dispute. The dominion has never conceded that because the provinces own the beds of the stream they necessarily own the waters running over them, where such waters are navigable.

In the discussion arising out of the big Beauharnois scheme, ownership of that power was admitted to be vested in Quebec. The province is on both sides of the river at that point. But a distinction is drawn between it and a case where the waters are international. It is felt that where there is doubt and conflict a mutual agreement between the dominion and the provinces will avoid future conflict and litigation.

Beauharnois Construction

Construction work on canal excavation for the huge power development of the Beauharnois Light, Heat & Power Company on the St. Lawrence River is already under way at Beauharnois, and plans for financing the project are now virtually completed. It is also indicated that the undertaking will be carried on by Beauharnois Power Corporation, which is to be the sole owner of the operating and construction subsidiaries.

At a recent meeting of the board of directors, R. O. Sweezey, prominent financial banker of Montreal, was appointed to the presidency of the company to fill the vacancy created by the resignation of Frank P. Jones.

The gigantic Beauharnois power project involves the digging of a canal fourteen miles in length connecting Lake St. Francis to Lake St. Louis to divert 40,000 cu.ft. of water per second from the natural channels of the St. Lawrence. The 83-ft. fall of the waters between Lakes St. Francis and St. Louis will be utilized in one power house near Melocheville, within 25 miles of the heart of Montreal. The company's engineers have stated that the commercial use of the 40,000 cu.ft. allowed to be diverted will justify construction of the proposed 500,000-hp. plant. The capital cost is estimated at $65,000,000.

West Kootenay Plans

The West Kootenay Power & Light Company is going ahead with its plans for extending operations outside of its present radius in British Columbia to embrace the Adams River, east of Kamloops and, generating 25,000 hp., to supply mines near Princeton. The company also is now ready to proceed with its dam at Granite, on Kootenay Lake, which was once discussed before the International Joint Commission on Boundry Waters. The dam will effect the level both of the lake, a navigable water, and the Kootenay River, which runs through Idaho before entering the lake. The company has still another project on hand, namely, the harnessing of the Pend Oreille River, near the United States boundary, where its plans call for an initial development of 80,000 hp. and an ultimate development of 120,000 hp.

Mason Regulator Company Builds New Boiler House

To meet increased steam demands for plant operation, and, at the same time, to provide steam for testing at somewhat higher pressure than that now available, the Mason Regulator Company, of Boston, has decided to build a new boiler house with space for two boilers. Only one of these will be installed at the present. Designed for 400 lb. pressure, the boiler will run normally at 250 lb. for general testing purposes. This pressure will be reduced to 150 lb. for general service and intermediate testing, and further reduced to low pressures for heating. The piping arrangement is so designed that with very little effort the 250-lb. system may be closed off and the boiler pressure run up to 400 lb.

An independent gas-fired superheater will be used to test valves under conditions as near as possible to those which will be met in actual service. Combined with the high-pressure, high-temperature testing equipment will be used in a research or experimental laboratory for development work.

Welded Pressure Vessel Tested by Train Wreck

Claims made for the use of electric welding in the fabrication of unfired pressure vessels were substantiated by a spectacular test carried out on steel spheres designed for the transportation of helium by the A. O. Smith Corporation, Milwaukee. While the tests have no direct bearing on the problem of welding fired pressure vessels, such as boilers, they are indicative of the increasing use of welding and the lengths to which tests are being carried to assure a duplication of natural con-

ditions. Representatives of the government, the railroad companies, insurance companies and other interested parties witnessed the tests.

The six-foot steel sphere, made from two 1½-in. plates pressed into hemispheres and electrically welded along the equatorial line, was loaded on a flat car between two 7¼-ton cylinders. After the sphere had been filled with compressed air at 1,250-lb. pressure, the flat car, traveling at a high rate of speed, was pushed off the end of a 25-ft. embankment. The tank was picked out of the wreckage undamaged and with its pressure perfectly maintained. This test was made to demonstrate the fact that containers of this type can be used to ship helium compressed to small volume without fear of loss or damage.

Previous to the man-made wreck, the sphere had been hammered for 72 hr. with an air hammer while under a hydrostatic pressure of 1,250 lb. The blows represented in intensity shock which would come to the sphere should it be transported in a car having a flat wheel, the total equivalent distance covered by such a car being 38,000 miles.

Following the wreck test, the routine shop acceptance test was repeated on the tank. Then the hydrostatic pressure was raised to 2,500 lb., at which point the elastic limit of the steel had been reached. The vessel was finally exploded at a pressure of 4,500 lb. Several of the ten pieces into which the shell was torn showed no breaks parallel to or along the weld.

1929 Electrical Code Adopted by A.S.A.

The 1929 edition of the National Electrical Code has been declared an approved American standard by the A.S.A. The code, originally drafted in 1897, has for 30 years been the basic guide for safe practices in the wiring of consumer premises for the use of electricity for light, heat and power. The forthcoming edition is the fifteenth revision of the original text. Fairly frequent and ofttimes extensive changes in its provisions are made necessary by rapid and new developments in electrical science and industry.

The code was drafted by a sectional committee under the sponsorship of the National Fire Protection Association. The electrical committee contains 75 members and alternates, representing 36 national and local organizations. These include federal, state and municipal officials, as well as men from eight subdivisions of the electrical industry, from the fire insurance organizations and from general interests, such as architects and building owners.

Technical provisions of the new edition are not materially different from those of the former "approved" text. Certain new practices in wiring methods have secured recognition and a need for economies in other methods has been satisfied.

THORNTON LEWIS (right), president of the American Society of Heating & Ventilating Engineers, returned recently from England, where he was entertained by J. Roger Preston (left), president of the Institution of Heating & Ventilating Engineers of Great Britain.

New Developments Made in Hydro-Electric Field

A permit granting water rights on the North River for the proposed $2,250,000 hydro-electric power project in Grays Harbor County, Wash., has been granted to the Western Washington Electric Light & Power Company, of Aberdeen, Wash. The undertaking, which will produce 54,545 theoretical hp. and 25,000 installed electrical hp., will require an appropriation of 5,000 sec.ft. of water from the flow of the North River, a tributary of Willapa Harbor. Rights were issued by the state hydraulics supervisor for the impounding of a total of 272,000 acre-ft. of water in a reservoir which will result from the construction of a concrete arch-type dam 153 ft. high, 400 ft. wide at the crest, and 180 ft. wide at the base. The development, to be complete on or before June 1, 1932, will have its power plant located at a stream point about ten miles south of the south shore of Grays Harbor, according to the plans.

Another development in northwestern United States is being planned along the North Santiam River, near Detroit, Ore. An application by the Northwest Power Company, a subsidiary of the Portland Electric Power Company, Portland, Ore., for rights along the river and Marion Lake is now pending. A joint hearing will be held on Sept. 24 before the state reclamation commission and the Federal Power Commission. The proposed development contemplates a storage project on Marion Lake, construction of a dam which will raise the waters of the lake nearly 70 ft., and a power plant on the North Santiam River near Detroit, Ore. It is proposed to develop 32,000 horsepower.

A smaller development on the Santiam River in Oregon is also being planned. O'Neill Brothers & Callahan, San Francisco paper manufacturers, have applied for permission to construct a dam 121 ft. high, 470 ft. long, and for the appropriation of 650 sec.-ft. of water from the river. The project would cost $800,000 and develop 5,557 horsepower.

Plans for two additional power units for Remmel dam, twelve miles southeast of Hot Springs, Ark., have also been announced. This project, which will be built by the Phoenix Utility Company for the Arkansas Power & Light Company, will be located between the present two units and the north shore, and an addition to the power house will be necessary. More than 10,000 cu.yd. of concrete will have to be poured.

In the East tentative approval has been granted by the Federal Power Commission for the construction of a $10,000,000 hydro-electric and flood-control project on the Chattahoochee River, near West Point, Ga. When completed and tied into the existing power facilities of the West Point Manufacturing Company, about 100,000 hp. will be available, it is estimated. The Hardaway Contracting Company, of Columbus, Ga., will build the dam, and McDonald & Company are engineers for the project.

Dr. Thoma to Lecture on Water Power at M.I.T.

Announcement has just been made of a series of ten lectures on hydraulic turbines and related subjects in water power plant design to be given by Dr. Ing. D. Thoma at the Massachusetts Institute of Technology, Cambridge, Mass., from Oct. 2 to 28. The lectures, which will be illustrated by moving and still pictures, will include the following topics:

Development of the Design of Kaplan Turbines and Some Recent Installations, Including the Ryburg-Schwörstadt Plant.
Cavitation in Hydraulic Turbines and Pumps.
Methods of Improving the Shape of Blades of Turbines and Centrifugal Pumps.
The Hydraulic Storage of Energy.
Dissipation of Energy in Fluids.
Experimental Determination of Losses in Pipe Fittings and Experiments With Various Devices.
The Hydro-electric Plants of the Mittlere Isar A. G. and Experimental Researches for Them.
Stability Problems Involved in Governing Hydraulic Turbines.
Self-supporting Pipes of Large Diameter With Thin Walls.
Effect of Scale in Model Tests and General Remarks About Hydraulic Laboratories for Turbine Researh.

Dr. Thoma has come to this country especially to give these lectures at M.I.T. He arrived in New York from Munich, Germany, on Sept. 15 abroad the liner "Stuttgart." A professor of hydraulics, water power machinery and plants, Dr. Thoma is director of the Hydraulic Institute at the Technische Hochschule of Munich.

PERSONALS

JOHN S. RIDDILE, who for nearly ten years was connected with RALPH D. MERSHON in hydro-electric development in Canada, has been appointed executive engineer of the Shawinigan Water & Power Company. Last year the Shawinigan company purchased the Laurentide Power Company of Grand Mere, with which Mr. Riddile was formerly identified.

ERNEST SLATER, editor of the British electrical weekly, the *Electrical Times*, will leave England about the middle of October for America with a view to obtaining the latest information concerning power development in the United States and Canada. Mr. Slater, who is a member of the I.M.E. and I.E.E., has visited several hundred power plants in the past twenty years.

COLONEL MAX TYLER, chief engineer of the Federal Power Commission, will be designated to serve as a member of the Board of Engineers for Rivers and Harbors, in addition to his regular duties with the commission.

W. S. RUGG, vice-president of the Westinghouse Electric & Manufacturing Company, has been appointed on the committee for the award during the next five years of the Edison medal given by the A.I.E.E. L. W. W. MORROW, editor of *Electrical World*, and R. F. SCHUCHARDT, of the Commonwealth Edison company, were also appointed to serve five years.

ANTHONY G. FLECK has joined the Girtanner Engineering Corporation in the capacity of mechanical engineer in charge of all construction.

ROBERT FOLLANSBEE, chief of the water resources branch of the United States Geological Survey, Denver, Colo., will represent the Colorado Engineering Council at the World Engineering Congress to be held in Japan during October.

COLONEL THAD D. BROWN, of Columbus, Ohio, has been appointed chief counsel of the Federal Power Commission to succeed MAJOR LEWIS W. CALL who is retiring.

JUDSON NEFF, formerly associated with the Southern Ice & Utilities Company, has accepted a position with the Merchants Ice & Cold Storage Company, Louisville, Ky.

PETER JUNKERSFELD, president and general manager of McClellen & Junkersfeld, Inc., New York, attended the convention of the Association of Edison Illuminating Companies, held recently in Quebec, Canada.

Coming Conventions

American Institute of Electrical Engineers. District meeting at Chicago, Ill., Dec. 2-4. Annual winter convention at New York, N. Y., Jan. 27-31, 1930. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Mechanical Engineers. Annual meeting at New York, N. Y., Dec. 2-6. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Society of Heating & Ventilation Engineers. Annual meeting in Philadelphia, Pa., Jan. 27-30, 1930, at the Benjamin Franklin Hotel. Secretary, A. V. Hutchinson, 33 W. 39th St., New York City.

National Association of Practical Refrigerating Engineers. Twentieth annual convention at the William Penn Hotel, Pittsburgh, Pa., Nov. 4-7. Secretary, E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

Third National Fuels Meeting at the Bellevue-Stratford Hotel, Philadelphia, Pa., Oct. 7-11.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

BUSINESS NOTES

SULLIVAN MACHINERY COMPANY of Chicago announces the appointment of Perry W. Olliver as manager of its San Francisco office to succeed the late Ray P. McGrath, who died on August 25. Mr. Olliver has been associated with the El Paso office of the company for the past eight years.

U. S. ELECTRICAL MANUFACTURING COMPANY of Los Angeles has added another wing to its plant, enlarging its engineering and administration departments and increasing motor production by approximately 50 per cent.

PALMER-BEE COMPANY of Detroit announce the appointment of Edwin Smiley, Bulletin Bldg., Philadelphia, as its eastern representative. Associated with Mr. Smiley will be Sherman Transeau, who for fourteen years was connected with the R. H. Beaumont Company of Philadelphia.

MICHIGAN VALVE & FOUNDRY COMPANY of Detroit has recently appointed the Herbert Kennedy Company, 22 East 42nd St., New York City, as its representative for New York, Massachusetts, Vermont, Connecticut, New Hampshire, Rhode Island and Maine.

GENERAL ELECTRIC COMPANY has named G. G. Jeter as manager of power apparatus sales of the newly consolidated General Electric Supply Corporation. His headquarters will be at Bridgeport, Conn. Mr. Jeter was formerly sales manager of the transformer accessory section of the General Electric Company.

HAHN ENGINEERING COMPANY, Lancaster, Pa., announces that Howard Butt, formerly sales manager of the Air Preheater Corporation, is now connected with its New York office at 101 Park Avenue.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard...	New York.....	$2.00 @$2.35
Kanawha.....	Columbus.....	1.25 @ 1.55
Smokeless.....	Cincinnati.....	1.85 @ 2.00
Smokeless.....	Chicago.....	2.25
S. E. Kentucky...	Chicago.....	1.35 @ 1.60
Steam.....	Pittsburgh.....	1.50 @ 1.60
Gas Slack.....	Pittsburgh.....	1.00 @ 1.10
Big Seam.....	Birmingham....	1.50 @ 1.75
Anthracite		
(Gross Tons)		
Buckwheat.....	New York.....	$2.50@$2.75
Barley.....	New York.....	1.40@ 1.50

FUEL OIL

New York—Sept. 19, f.o.b., Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Sept. 16, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.5454 per bbl. or 42 gal.; 26@28 deg., $1.5954 per bbl.; 28@30 deg., $1.6454 per bbl.; 30@32 deg., $1.6954 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 38@40 deg., distillate, 5.73c.

Pittsburgh—Sept. 11, f.o.b. local refinery, 30@34 deg., fuel oil, 4.125@4.25c. per gal.; 36@40 deg., 4.25@4.5c. per gal.

Philadelphia—Sept. 15, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati—Sept. 10, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.25c. per gal.; 30@32 deg., 5.5c. per gal.

Chicago—Sept. 13, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 85c. per bbl.; 30@32 deg., $1.04½ per bbl.

Boston—Sept. 15, tank-car lots, f.o.b., 12@14 deg., Baumé, 4.45c. per gal.; 28@32 deg., 5.5c. per gal.

Dallas—Sept. 14, f.o.b. local refinery, 26@30 deg., $1.30 per bbl. or 42 gallons.

Trade Catalogs

Oil Burners—A new catalog on Quinn oil burning equipment published by the Combustion Engineering Corporation, New York, N. Y., gives specifications and illustrations of this type of equipment. Cross-sectional diagrams of the burners illustrate their construction very well.

Belt Lubricant—A small leaflet listing the reasons for the use of its belt lubricant has been published by Alexander Brothers, Inc., Philadelphia, Pa. Directions for using the lubricant are also given in the leaflet.

Thermo-Compressors — Schutte & Koerting Company, Philadelphia, Pa., has recently published a new edition of its bulletin 4-F, covering steam-jet thermo-compressors. The bulletin not only describes the standard hand-controlled thermo-compressor but also illustrates and describes the automatic thermo-compressor, used where close regulation is desired.

Steam Traps—The W. B. Connor Company, Inc., New York City, has recently published an interesting booklet entitled "Condensate, In Dollars and Cents Value and How It Can Be Effectively Conserved." The whole problem of condensate is treated from a non-technical point of view in this pamphlet. In addition, the theory and construction of the various types of steam traps manufactured by this company are fully described.

Floats—Bulletin No. 929, just issued by W. H. Nicholson & Company, Wilkes-Barre, Pa. describes Nicholson welded-steel, non-collapsible floats for steam traps, water columns, float valves, etc. A price list is included.

Electrical Apparatus—Four leaflets have recently been released by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Circular 1852 describes type F-24 and F-24-R oil circuit breakers for medium interrupting capacity use. Pamphlet 20378 includes material on the general features and construction of the new 25-50-kw. direct-current geared turbine-generator sets. Leaflet L-20377 brings out several new features on the geared turbine-generator units.

Water Wheels—The hydro-electric installation at Middleport, N. Y. for the Buffalo, Niagara & Eastern Power Corporation is described in a leaflet, W 206, recently issued by the James Leffel & Company, Springfield, Ohio.

Blowers—Bulletin No. 110 recently published by the Connersville Blower Company, Connersville, Ind., describes the "R-S" and "R-B" series of Connersville rotary positive blowers suitable for the medium range of air volumes and pressures. The bulletin explains the general operating characteristics of the blowers and some of the features of design. A revised table of ratings is also included.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Russellville — City, c/o C. C. Nugent, Mayor, plans an election Oct. 15, to vote $200,000 bonds for the construction of a 50 x 80 ft. power plant and distribution system including two 600 and one 360 hp. Diesel engines, etc. W. L. Winters, 311 Merchants National Bank Bldg., Fort Smith, is engineer.

Delaware — Bd. of Water Commissioners, Public Bldg., Wilmington, will receive bids until Oct. 16, for the construction of a dam for Old Mill reservoir project. Estimated cost $2,000,000. Fuller & McClintock, 170 Broadway, New York, N. Y., are engineers. Bids for two pumping stations, electrically driven pumps, etc. later.

Ga., Griffin—City is having plans prepared for the construction of a waterworks system including pump house, filter plant, etc. Estimated cost $300,000.

Idaho, Mount Home—E. and B. Stevens, plan the construction of a 200 hp. hydro-electric plant on Snake River for irrigation pumping. Estimated cost $48,000.

Ill., Aurora — Lyon Metal Products Co. awarded contract for the construction of a 1 story power plant to Sumner-Sollitt Co., 307 North Michigan Ave., Chicago, Ill. Estimated cost $75,000.

Ill., Chicago—Commonwealth Edison Co., 72 West Adams St., awarded contract for masonry, etc., for a 1 story addition to electric sub-station at 1920-22 South Harding Ave. Estimated cost $30,000.

Ill., Decatur—Citizens Building Corp., c/o J. L. Simons Co., 4010 West Madison St., Chicago, Gen. Contr., will build a 12 story office and stores building at 254 North Water St. Estimated cost $750,000.

Ind., Attica—Company forming, c/o Universal Construction Co., 1925 Massachusetts Ave., Contr., will build a 5 story hotel and sanitorium. Estimated cost $500,000. Steam heating system, etc., will be installed.

Md., Perry Point — U. S. Veteran's Bureau, Construction Div., Arlington Bldg., Washington, D. C., will receive bids until Oct. 8, for complete additions to refrigeration plant at U. S. Veteran's Hospital here.

Mass., Chatham—Bd. of Selectmen, is having plans prepared for the construction of a waterworks system and pumping station. Estimated cost $25,000. H. Lymonds, 70 State St., Boston, is engineer.

Mass., Westwood—Bd. of Selectmen, is having preliminary surveys made for the construction of a water supply system including wells, pumping system, etc. Estimated cost $175,000. E. Worthington, 4 Pearl St., Dedham, is engineer.

Mass., Woburn—Edison Electric Illuminating Co., 39 Boylston St., Boston, awarded contract for the construction of a 2 story, 50 x 160 ft. electric sub-station on Pond St. to F. T. Ley Co., Statler Bldg., Boston. Estimated cost $275,000. Also taking bids for addition to power sub-station at Dorchester. $40,000. Bigelow, Wadsworth, Hubbard & Smith, 11 Beacon St., Boston, are architects.

Mich., Ann Arbor—University of Michigan, awarded contract for a 4 story dormitory on Tappan Ave. to James Baird Co., 101 Park Ave., New York. Estimated cost $750,000. Steam heating system, elevators, etc. will be installed.

Mich., Detroit—Michigan Bell Telephone Co., 1365 Cass Ave., awarded contract for a 7 and 12 story office and warehouse at Woodrow Wilson Ave. to Bryant & Detwiler, 2806 Union Trust Bldg. Estimated cost $1,000,000. Steam heating system, boilers, elevators, etc. will be installed.

Mich., Detroit—Malcolmson & Higgnbotham, 1219 Griswold St., Archts., will receive bids until Oct. 2, for the construction of a 10 story lodge temple including steam heating, ventilation and refrigeration systems, boilers, elevators, swimming pool, etc. on East Jefferson St. for Detroit Lodge No. 34, B.P.O.E., Building Committee, Cass Ave. and Lafayette Blvd. Estimated cost $1,500,000.

Mich., Detroit—J. B. Book, Jr. 1610 Washington Blvd., is receiving bids for the construction of an 8 story office building including steam heating and ventilation systems, boilers, elevators, etc. on Washington Blvd. Estimated cost $650,000. L. R. Hoffman, 1610 Washington Blvd., is construction engineer.

Mich., Kalamazoo—Kalamazoo State Hospital, H. Ostrander, Supt., plans the construction of a group of hospital buildings including power house, etc. Estimated cost $1,732,000. G. W. Graves, 233 John R. St., Detroit, is architect.

Mich., Oxbow (mail Sodus) — Consumers Power Co., Jackson, subsidiary of Commonwealth Power Corp., 14 Wall St., New York, N. Y., awarded contract for the construction of an earth dam, 3,500 ft. long and 100 ft. high with concrete core, concrete spillways, power house with three vertical a.c. turbo generators on Muskegon River, total output of 40,000 hp. to Stevens & Wood, Consumers Power Bldg., Jackson.

Minn., Minneapolis—Company, c/o A. Erickson, 908 2nd Ave. S., plans the construction of an 18 or 20 story hotel at 9th St. and 2nd Ave. S. Estimated cost $2,000,000. Architect not announced.

Minn., Minneapolis — Local Manufacturers, c/o E. S. Griffith, 743 Washington Ave. N., Ch. of Comm., postponed indefinitely the construction of electric power plant at North Minneapolis Dist. $100,000. City Council refused to authorize.

Mo., Kansas City—Jackson County, awarded contract for the construction of a 4 story hospital to T. H. Lishear Construction Co., 447 East 55th St. Estimated cost $500,000.

Miss., Meridian—East Mississippi State Hospital, State Bldg. Comn., Jackson, will receive bids until Oct. 3, for the construction of a group of hospital buildings including new power house, service building, etc. here. Estimated cost $225,000. R. C. Spunger, Jackson, is architect.

Mo., Campbell—City is having preliminary plans prepared for the construction of a municipal light and power plant and distribution system including Diesel engine generating unit, etc. Estimated cost $60,000. Russell & Axon, 6200 Easton Ave., St. Louis, are engineers.

Mo., Salem — City, c/o G. H. Slawson, Mayor, awarded contract for the construction of an electric light plant to J. H. Butler, Salem. $24,000. Also distribution system to M. B. Hall, Inc., 1423 Pine St., St. Louis, $13,309. Generating equipment awarded.

Mo., St. Louis—Melbourne Hotel Co., c/o A. M. Cornwell, Pres., 111 North 7th St., will build an 18 story addition to hotel at Grand and Lindell Blvds. Estimated cost $1,000,000. Preston J. Bradshaw, 718 Locust St., is architect. Brussel & Viterbo, 1630 Arcade Bldg., are engineers. Work will be done by separate contracts.

Neb., Omaha — Nebraska Power Co., 17th and Harney Sts., awarded contract for power plant, turbine and switchhouse addition to Phoenix Utility Co., 4th and Jones Sts. Estimated cost $100,000.

N. J., Bayonne—Bd. of Commissioners, City Hall, will receive bids until Oct. 1, for the

construction of a 5 story municipal building including steam heating and ventilation systems, boilers, elevators, etc. at Ave. C between 27th to 28th Sts. Estimated cost $1,000,000. P. A. Vivarttas, 110 48th St., Union City, is architect.

N. J., Bound Brook—F. Y. Joannes, 420 Lexington Ave., New York, N. Y., Archt., is receiving bids for addition to boiler room here for Calco Chemical Co., Bound Brook Rd. Estimated cost $40,000.

N. J., Englewood—E. M. Coffey Esq., c/o R. Jahelka, 15 West 44th St., New York, N. Y., Archt., will receive bids until Oct. 15, for the construction of a 10 story apartment building including steam heating and refrigeration systems, boilers, elevators, etc. on Engle St. Estimated cost $500,000.

N. J., Haledon—City is having plans prepared for the construction of a new water storage reservoir and pumping station. Estimated cost $150,000. H. J. Harder, Paterson, is engineer.

N. J., Jersey City—C. Shilowitz, 26 Journal Sq., Archt., will receive bids about Oct. 15 for a 4 story garage, show rooms, etc., including steam heating and ventilation systems, boilers, etc., at Sip and Summit Aves., for J. Goldenberg, 80 Woodland St., Englewood. Estimated cost $500,000.

N. J., Newark — Larkey Holding Co., c/o Fanning & Shaw, 49 Ward St., Paterson, will receive bids about Oct. 15, for a 21 story office building including steam heating, ventilation, systems, boilers, elevators, etc. at Market and Halsey Sts. Estimated cost $1,000,000.

N. Y., New York—L. V. Heusen, 230 Park Ave., plans the construction of an apartment building including steam heating system, etc. at 433 East 52nd St. Estimated cost $3,500,000. Bottomley, Wagner & White, 112 East 55th St., are architects.

N. Y., New York—United Electric Light & Power Co., 130 East 15th St., will soon award contract for a 1 story, 249 x 437 ft. boiler house and engine room at 134th St. and Locust Ave. Estimated cost $75,000. C. E. Dell, 130 East 15th St., is architect.

O., Cincinnati—Christ Hospital, Auburn Ave., awarded contract for a 10 story hospital to Max Penker Construction Co., Summer St. Estimated cost $1,500,000.

O., Cincinnati—Thomas Emery's Sons, Inc., 115 East 4th St., received lowest bid for the construction of a 43 story hotel and office building at 5th and Vine Sts. from Starrett Building Co., 8 South Dearborn St., Chicago, Ill. Estimated cost $14,000,000. W. W. Ashlschlager, Inc., 65 East Huron St., Chicago, is architect.

O., Cleveland—Clark-Elliott Co., c/o W. B. Chamberlain, Osborne Bldg., awarded contract for a 14 story commercial building and office at East 105th St. and Carnegie Ave. to Austin Co., 16112 Euclid Ave. Estimated cost $1,500,000.

O., Cleveland—Champion Machine & Forging Co., H. D. Krauss, Secy. and Treas., 3695 East 78th St., awarded contract for the construction of a 1 story, 50 x 60 ft. boiler house at 3695 East 78th St. to A. M. Higley Co., Plymouth Bldg. Estimated cost $40,000.

O., Cleveland—Cuyahoga County Jail Comm., F. Husak, Clk., Court House, awarded contract for a 4 and 13 story county jail on Payne Ave. to Hunkin-Conkey Construction Co., Newman-Stern Bldg. Estimated cost $1,250,000. Steam heating system, etc., will be installed.

O., Dayton—Construction Quartermaster, received lowest bid for the construction of a boiler house, stack and tunnel, etc., at Wright Field from McAleenan Corp., 25th and A. V. R.R., Pittsburgh, Pa. $208,865.

O., Youngstown — Ice & Fuel Co., W. R. Lowry, Mgr., 1421 West Federal St., is having plans prepared for a 2 story, 78 x 166 ft. ice plant. Estimated cost $250,000. G. R. Bright, 2615 12th St., Detroit, Mich., is architect.

Okla., Mangum—Crystal Ice Co., is having plans prepared for the construction of a 500 ton ice and cold storage plant. Estimated cost $75,000. Private plans.

Okla., Oklahoma City—Oklahoma Gas & Electric Co., Insurance Bldg., plans the construction of two sub-stations in connection with 33,000 v. electric transmission line. Estimated cost $30,000. Byllesby Engineering & Management Corp., 231 South La Salle St., Chicago, Ill., is engineer.

Ore., Medford—Consolidated Light & Power Co. awarded contract for the construction of a power plant, dam and diversion works on Elliott and Joe Creeks and Applegate River for generation of 600 hp. to T. A. Sweeney, Railway Exchange Bldg., Portland. Estimated cost $100,000. Hydraulic and electrical machinery, electrical mining machinery, etc. will be required.

Ore., Medford—Medford Water Power & Development Co., plans to expend $300,000 for the construction of dams and a canal 35 mi. long on Big and Little Squaw Lakes. Surveys not yet made. Address H. A. Hutton, Medford, or F. R. Chadwick, Western Loan & Finance Bldg., Portland.

Pa., East Pittsburgh—B. H. Prack, Martin Bldg., N. S., Pittsburgh, Archt., will receive bids until Sept. 25 for the construction of a 34 x 63 ft. power house and 3 story, 60 x 90 ft. service building on Ardmore Blvd. for Westinghouse Electric & Mfg. Co., East Pittsburgh.

Pa., Frazer — Bd. of Supervisors, Boro of Tarentum, Frazer Township, will receive bids until Oct. 1, for the construction of a sewage system including pumping plant, etc. Estimated cost $25,000. C. E. Miller, Jenkins Arcade, Pittsburgh, is engineer.

Pa., Glenwillard—U. S. Engineers Office, J. J. Bain, Dist. Engr., Keenan Bldg., Pittsburgh, received lowest bid for the construction of a hydro-electric plant at Deadman's Island on Ohio River near here from Hoppes Water Wheel Co., Springfield, O.

Pa., Grove City—Cooper Bessemer Corp., is having plans prepared for addition to power plant. Estimated cost to exceed $40,000. Private plans.

Pa., State College—Pennsylvania State College, Dept. of Buildings, awarded contract for the construction of a power plant to J. G. White Engineering Corp., 43 Exchange Pl., New York, N. Y. Estimated cost to exceed $100,000.

Tex., Beaumont—United Charities, Z. F. Keith, Chn. Bldg. Comm., Cherry-Leicht Bldg., is having plans prepared for the construction of a United charities home including hospital, cold storage unit, etc. Estimated cost $150,000. Wilson & Heartfield, 917 Goodhue Bldg., are architects.

Tex., Big Springs—Texas & Pacific Ry. Co., Dallas, is receiving bids for the construction of a railway division terminal, including round house, machine and blacksmith shops, power house, boiler house, oil house, etc., here. Estimated cost $1,000,000. E. F. Mitchell is chief engineer.

Tex., Mercedes—R. W. Alford, c/o Alford Creamery, is receiving bids for the construction of a 50 ton ice plant here. Estimated cost $80,000.

Tex., Port Aransas—Mustang Island Industries Inc., c/o G. B. Munsill, Pres., awarded contract for the construction of a new electric light plant and 60 ton ice plant to L. Summeral, Corpus Christi. Estimated cost $110,000.

Tex., Sugarland—Imperial Sugar Co., plans the construction of a power plant, including equipment in connection with sugar refinery. Private plans.

Wash., Seattle—Dept. of Lighting, J. D. Ross, Supt., is having plans prepared for the construction of a 26 story office building, including central power sub-station on a 111 x 240 ft. site at 3rd Ave. between Madison and Spring Sts.

Wis., Milwaukee—O. Bachman, 530 Wisconsin St., is having plans prepared for the construction of a 22 story office and stores building at 6th St. and Wisconsin Ave. Estimated cost $1,000,000. Weary & Alford, 1923 Calumet Ave., are architects.

Ont., Simcoe—Norfolk County Fruit Growers Assn., plans to erect and equip a cold storage and refrigeration plant for handling and storing apples. Estimated cost $100,000. F. C. Patterson, c/o owner, is interested.

Equipment Wanted

Compressor—M. McDonough Co., 821 Broadway, Saugus, Mass., is in the market for an 8 x 8 belt driven compressor, 12,000 gal. underground fuel tank.

Compressors, Motors, Switchboard, etc. — Pihuls & Hill, 112 West 42nd St., New York, N. Y., Engrs., will receive bids about Sept. 26 for four new ammonia compressors, two d.c. compressors; one 150, two 100 and one 75 hp. synchronous motors, two transformer vaults, 300 kw. capacity each, two 1,100 ft. steel and tube condensers, two 800 g.p.m. water pumps, switchboard, etc., for proposed alterations to power plant for Union Storage Co., 2nd and Liberty Sts., Pittsburgh, Pa.

Electric Motor—J. Glennie, Ward Hill, Mass., in the market for a 35 to 50 hp., 3 ph. 220 v. electric motor.

Ice Plant Equipment—Central Power & Light Co., Frost Bldg., San Antonio, Tex., is receiving bids equipment for proposed ice plant at Elsa. Estimated cost $45,000.

Engine, Generator, Switchboard, etc.—Town of Thibodaux, La., C. N. Folse, Mayor, will receive bids until Sept. 27 for a 500 b. hp. Diesel oil engine, 350 kw. a.c. generator, switchboard and necessary accessories and auxiliaries for proposed waterworks and sewer extensions.

Pumping Equipment, etc.—City of Brackettville, Tex., pumping equipment, etc., for proposed improvements to waterworks system. Estimated cost $60 000.

Pumps—City of Mt. Vernon, Wash., will soon receive bids for pumps, etc., in connection with proposed sewage system. Estimated cost $100,000.

Pumps, etc. — City of Longview, Wash., pumps, etc., for proposed waterworks improvements. Estimated cost $300,000.

Industrial Projects

Ala., Gadsden—Gulf States Steel Co., B-M Bldg., Birmingham, will soon award contract for the construction of a sheet mill here. Estimated cost $2,000,000.

Conn., East Hartford—Pratt & Whitney Aircraft Co., 450 Capital Ave., Hartford, awarded general contract for a 2 story, 400 x 1,500 ft. factory on South Main St. here to Turner Construction Co., 178 Tremont St., Boston. Estimated cost $1,500,000.

Fla., Pensacola—Newport Co., J. H. McCormack, Pres., plans the construction of a plant for the manufacture of insulating boards. Estimated cost $1,000,000.

Ga., Atlanta—B. F. Goodrich Rubber Co., South Main St., Akron, O., will soon receive bids for the construction of first unit of plant, 4 story, 200 x 600 ft. on Hemphill Ave., here. Estimated cost $1,500,000. McDonald & Co., Southeastern Trust Bldg., Atlanta, are architects. R. S. Fiske, Healey Bldg., is engineer.

Ill., Rock Island—International Harvester Co., 606 Michigan Ave., Chicago, awarded contract for the construction of a 1 story wheel manufacturing plant here, to Priester Construction Co., American Commercial Bank Bldg., Davenport, Ia. Estimated cost $300,000.

Ind., Auburn—Auburn Auto Co., will receive bids until Oct. 1 for a 2 story, 200 x 240 ft. engineering building. Estimated cost $220,000. A. M. Strauss, Fort Wayne, is architect.

Ind., Fort Wayne—Dudlo Mfg. Co., Wall St., awarded contract for a 65 x 75 ft. factory, including boiler house, to Indiana Engineering & Construction Co., 201 Central Bldg. Estimated cost $47,420.

Ind., Indianapolis — Sterling Laundry Co., 735 Lexington Ave., awarded contract for the construction of a laundry and power plant to J. G. Karstedt Co., 254 North Capitol St. Estimated cost $46,100.

Ind., Indianapolis — U. S. Fibre Box Co. awarded contract for the construction of a factory at Martindale and Roosevelt Ave. to B. Bass, 4003 North New Jersey Ave. Estimated cost $200,000.

Mich., Berrien Springs—Clark Equipment Co., Buchanan, awarded contract for a 1 story, 130 x 205 ft. axle plant, here, to Frank L. Shoemaker, Sturgis. Estimated cost $75,000. Electric motors and miscellaneous machine equipment for the manufacture of automobile axles will be required.

Mich., Detroit—Silent Automatic Corp., 255 Meldrum Ave., is having plans prepared for the construction of a 7 story, 100 x 120 ft. factory for the manufacture of oil burners and equipment. Estimated cost $200,000. Private plans. Electric motors, etc., will b required.

N. J., Bound Brook — Bakelite Corp., 247 Park Ave., New York, awarded contract for the construction of a new factory here, to Francisco & Jacobus, 511 5th Ave., New York.

N. J., Newark—Tung Sol Lamp Works, Inc., 95 8th Ave., will receive bids about Oct. 1 for the construction of a 4 story, 100 x 140 ft. factory. Estimated cost $150,000. Fougner & Gautier, 103 Park Ave., New York, N. Y., are architects.

N. J., Passaic — U. S. Rubber Co., 1790 Broadway, New York, N. Y., is having plans prepared for the construction of a 4 story factory here. $1,000,000. Lockwood Greene Inc., 100 East 42nd St., New York, are engineers. Also awarded contract for a 1 story, 100 x 105 ft. factory on Valley St., Providence, R. I., to Cruise Construction Co., 19 Dexter St., Pawtucket. $100,000.

O., Akron—Firestone Tire & Rubber Co., H. D. Firestone, Pres., South Main St., is having plans prepared for a 7 story, 110 x 180 ft. factory. Estimated cost $500,000. D. H. Hoener, c/o owner, is chief engineer.

O., Canton — Hercules Motor Corp., 140 Halliwell Pl., S. E., awarded contract for the construction of a 93 x 200 ft., factory on 11th St., S. E. to E. G. Landor & Sons Co., 6344 Renkert Bldg. Estimated cost $40,000.

O., Cleveland — Bowne-Fuller Co., A. H. Preston, Purch. Agt. 1912 Scranton Rd. (iron and steel) awarded contract for the construction of a 5 story, 77 x 215 ft. factory, to H. K. Ferguson Co., Hann Bldg. Estimated cost $250,000.

O., Cleveland — Newburgh Steel Co., 6318 Rinsmans Rd., is having plans prepared for a 1 and 2 story factory. Estimated cost $40,000. G. S. Rider Co., Century Bldg., is architect.

O., Warren—Republic Iron & Steel Co., E. T. McCleary, Pres., South Market St., Youngstown, plans the construction of a new mechanical tubing and conduit department here. Estimated cost $1,000,000. Private plans.

Pa., Philadelphia—I. Fishman & Son, 10th and Allegheny Sts., awarded contract for a 1 and 2 story, 375 x 480 ft. factory for the manufacture of soda fountains at Erie and F Sts. to Turner Construction Co., 1700 Walnut St. Estimated cost $1,500,000.